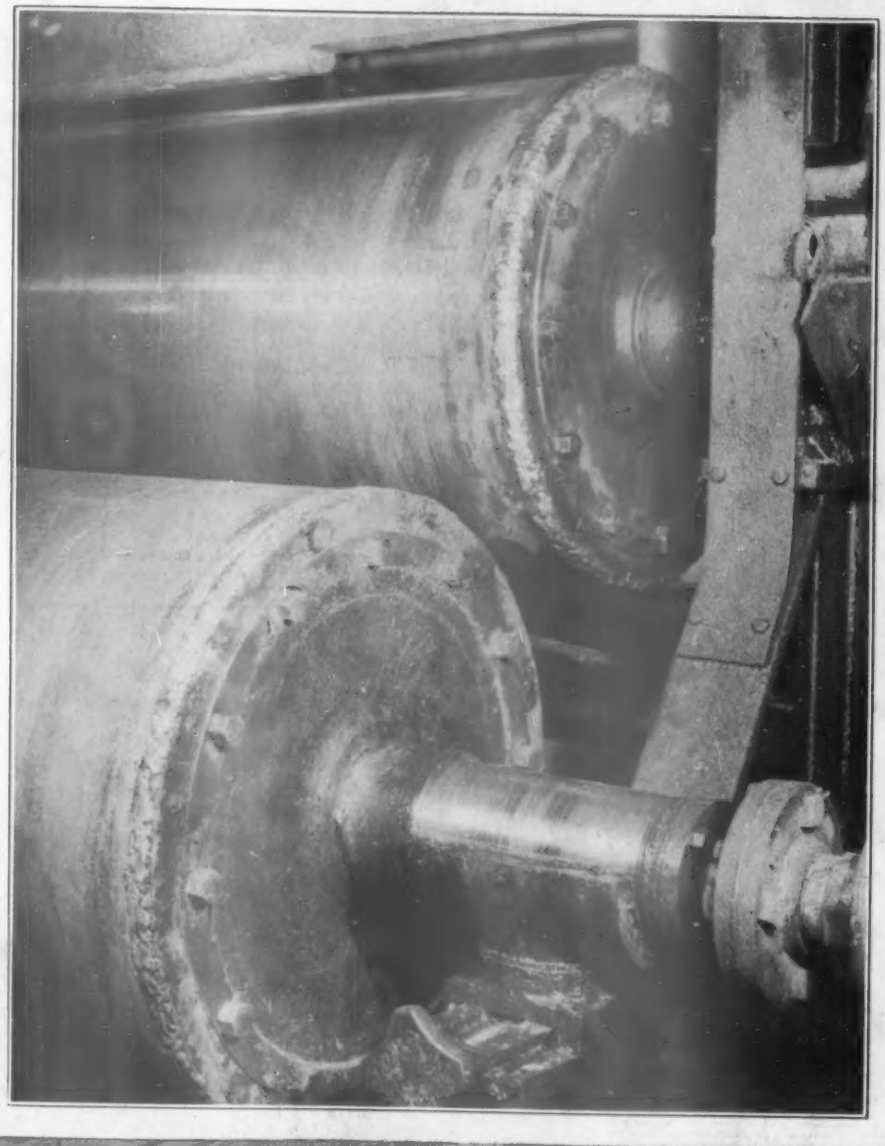
The WELDING ENGINEER

August
1934
Vol. XIX No. 8



cylinder shells
d to cast brass
by the carbon arc,
g leaktight joints,
t warpage.

(See Page 19)

nee- Business and Technical Journal of the Welding Indust

USS

PLYKROME

can be welded

. . . or hot formed

without subsequent heat treatment

For those articles in which heat treatment is difficult or impossible after fabrication, USS Plykrome is ideally suited. Its corrosion-proof surface is of Stabilized USS 18-8 Stainless Steel. This special stainless resists intergranular attack even under the most severely corrosive conditions.

As a consequence Plykrome can be welded successfully or subjected to high temperatures during fabrication or service without loss of its corrosion-resistant qualities. Furthermore, the stabilizing treatment given to Plykrome to insure its resistance to corrosion is such that the steel backing is put into the best possible condition for forming. This unique quality makes Plykrome a practical metal for many applications which cannot employ unstabilized stainless steel.

Additional information on the use of Plykrome in specified installations may be had upon request.

A striking indication of the difference between ordinary 18-8 stainless and the stabilized 18-8 used as the surface veneer on USS Plykrome. Here a piece of low carbon USS 18-8 (on the left) has been welded to USS Stabilized 18-8 (on the right) and subsequently put in an acid bath. Note the manner in which the unstabilized steel has been corroded adjacent to the weld. The stabilized stainless, however, is entirely free from attack.

U S STEEL

Illinois Steel Company

208 S. LA SALLE STREET, CHICAGO, ILL.

SUBSIDIARY OF UNITED STATES STEEL CORPORATION

U S S CHROMIUM-NICKEL ALLOY STEELS ARE PRODUCED UNDER LICENSES OF THE CHEMICAL FOUNDATION, INC., NEW YORK, AND FRIED. KRUPP A. G. OF GERMANY

MEMBER AUDIT BUREAU OF CIRCULATIONS

ABP

THE WELDING ENGINEER

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AUGUST, 1934

Vol. 19, No. 8

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Published on the 15th of each month by The Welding Engineer Publishing Company, 608 S. Dearborn St., Chicago, Ill. Telephone Webster 7134.

G. H. Mackenzie, *President and Treasurer* F. L. Spangler, *Editor*

REPRESENTATIVES

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PACIFIC COAST: W. R. McIntyre, 1115 Tyler St., Glendale, Calif.

Subscription, payable in advance: United States and possessions, $3 a year; Foreign Countries, $4 a year; Canada, $4 a year; Single copy, domestic, 25 cents; Single copy, foreign, 30 cents. Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

FOREIGN REPRESENTATIVES: GREAT BRITAIN—Capt. D Richardson, 26 Winterbrook Road, Herne Hill, London; AUSTRALIA and NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand; SOUTH AFRICA—J. W. Arnison, 35a Victoria Avenue, Benoni, Transvaal, South Africa.

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· E D I T O R I A L ·

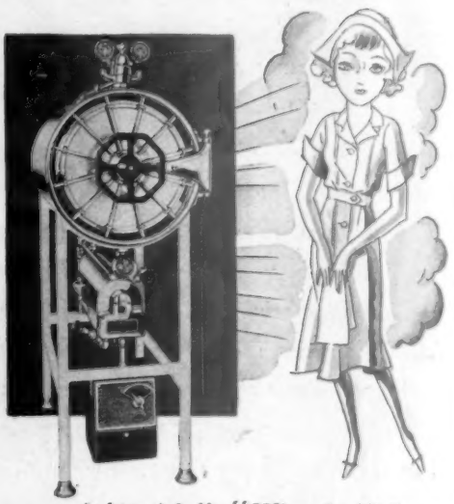
THE BUSINESS OF METAL SPRAYING

The art of spraying metal by melting and atomizing in the gas flame, has now been in experimental and practical use for a sufficiently long time that one should feel safe in drawing certain definite conclusions with respect to the practicability of the process from a commercial standpoint, what is to be expected on the part of the operator in the matter of knowledge and skill, and what type of commercial unit will stand to benefit the most in exploiting the process. ¶ The metal spraying process has been amply demonstrated as being a practical and useful one. Many industrial concerns as well as a number of welding and general repair shops have invested in metal-spraying equipment and have conducted a metal-spraying business to their complete satisfaction and with profit. Yet, there are those who have attempted to use the process and have finally given it up with a resigned sense of disgust. ¶ Disappointing results, in the main, can be classed under two headings: those due to lack of experience and of knowledge of the equipment itself, and those resulting from improper application. Some who have gone into the metal-spraying business with high hopes have become disillusioned because they failed fully to realize that they were handling a highly sensitive precision tool which gave consistently good performance as long as it was in the hands of one who thoroughly understood its construction and the theory of operation, so any trouble could be quickly diagnosed correctly. But when turned over to a mechanic or welder, it misbehaved like the spoiled child in the presence of the visiting minister. ¶ As a result of this condition, manufacturers of metal-spray guns have been greatly burdened by having to spend a great deal of money and effort in servicing their equipment. They have now come to the realization that every gun placed in the hands of one not fitted by knowledge or temperament to use it correctly, is not good business for the manufacturer, the buyer of the gun, or the customer who specifies metal-spray work. Such a condition leads to improper applications, costly operation, and expensive servicing, and nobody is benefited. ¶ Equipment that would not be so sensitive or so complicated but that any good mechanic or welder could quickly learn to operate it and keep it in repair is a goal the manufacturers of metal-spray guns are striving for, and considerable progress is being made in that direction. ¶ Many failures of metal-spray coatings cannot be charged to the operator who handles the gun, but are the result of improper preparation of the surfaces or the use of metals that were not suited to the conditions of service. There is the case of a customer who got the kind of coating he specified for a tank. After two years' service, the coating was still in good condition. Soon complaints came one after the other that the coating was going to pieces. The customer then admitted that he had just recently filled the tank with a chemical other than that for which the coating was intended. Moreover, the change from a coarse steel grit to a fine steel grit for sand-blasting has been known to spell the difference between success and failure. ¶ It would seem that the successful metal-spray artisan must not only be a mechanic but also a metallurgist and chemist, and a knowledge of proportion and design as well as of colors would be of material help in using the process for decorative work. ¶ Manufacturers of metal-spray equipment seem pretty well agreed among themselves that this process is not suited commercially to the usual run of job-welding shops. The exceptional shop is the exception, but they are few. Even though it might be possible to draw on a large industrial section for business, it must be remembered that the getting of business is only half the job—the customer must be satisfied or he won't repeat. The metal-spray process being what it is, and a high degree of a special type of skill being required to master the process and give satisfaction, it is apparent that investment in a gun and auxiliary equipment for sand-blasting should be made only after more consideration than some purchasers of such equipment have given. ¶ Those who will undertake to learn and apply the process intelligently will be staking their claim in a growing field, the limits of which have not yet been explored. Whether the bonanza turns out to be gold or pyrite remains to be seen, but the results will depend in large degree on the individual's initiative and qualifications.

AN ADVERTISEMENT FOR NICKEL-BEARING WELDING RODS MANUFACTURED BY THE INTERNATIONAL NICKEL COMPANY

"I Cover The WELDING FRONT

and it takes SOME covering." NICK RODDER



NOT LONG ago we get a set of blueprints from the contractors for the Alkali, Inc. This is a Nickel-Clad Steel tank job, and a regular one. To be used for settling caustic soda. It's 18′ diameter and 25′ overall height, with a conical bottom.

All welded. Not even one rivet hole.

The boss wrote the erecting crowd, explaining our ideas of how to handle it. And then one day he gets a hurry up phone call . . . "Send Nick Rodder down here to make sure our welding crew don't get off to a wrong start".

So next morning I'm headed towards the Southwest. It's a hot trip, but it was worth it.

Here's the procedure: ¼", 5/16" and ⅜" sketch plates of 10% Nickel-Clad Steel are veed on the steel side, then tacked and welded as in regular steel welding. Then we gouge the Nickel side of the seams so as to clean out and get uniform depth of groove. After which we weld-in with Nickel Metallic Arc Welding Wire (for vertical welding). And we're careful to make certain of complete continuity of the Nickel on the entire inside surface of the tank.

These contractors are a bang-up crowd, and they soon get into the swing of the work. As a matter of fact, the Boss in charge says to me as I'm getting out of my shop clothes, "Nick", he says, "I hope we get a chance to build some more of these Nickel-Clad tanks. They're swell cans, and I don't see anything so very tough about building them . . . only being a little particular with all parts of the work." And that's just about all there is to it. *All I had to do was show the Alkali boys the kinks of vertical welding with Nickel, and they sure turned out a sweet job.*

☼ ☼ ☼

My next call is to a plant that makes sterilizers for hospitals. Monel Metal, they are, and welded "longitudinally and circumferentially" as the specifications read.

These shells have to be good. They've got to be able to stand steam pressure. You know how it is in a hospital. Some young nurse sets a sterilizer going, and then goes to the window and begins thinkin' about the rich old patient she hopes to get some day to fall for her. About the time she is seeing the two of them walking down the aisle, with all his friends throwing bonds at her, she hears a big BANG . . . or else she remembers just in time!

To get back to my part of this job, they show me the set-up. Shells vary from 16" to 22" diameter, 3′ to 6′ long. These are rolled to shape from Monel Metal Sheet, .093" and .062". The larger diameters are made even heavier.

We rig up a jig and metallic arc weld 'em with 5/32" No. 30 Monel Metal Metallic Arc Welding Rod. The welder gets the hang of the thing in just a few tries, and the first five jobs he turns out pass the pressure tests without any trouble a-tall.

The welder grins when the inspector puts his O. K. on 'em, and he tells me, "Nick, I'm going to the Hospital tonight". "What for?" I says.

"Oh", he says kinda sheepish, "I know a nurse!" Sooooo!

As ever,

Nick Rodder

INCO WELDING SERVICE

INCO WELDING RODS and FLUXES

for PURE NICKEL

Oxy-Acetylene . . . "T" Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

for MONEL METAL

Oxy-Acetylene . . . Monel Gas Welding Wire. For flux see *below.
Metallic Arc . . . INCO Monel Metal Arc Welding Wire No. 30
Carbon Arc . . . INCO Monel Carbon Arc Welding Wire No. 20.

for INCONEL

Oxy-Acetylene . . . Inconel Gas Welding Wire. For flux see **below.
Metallic Arc . . . Inconel Metallic Arc Welding Wire No. 32.

for NICKEL-CLAD STEEL
(for welding of Nickel side)

Oxy-Acetylene . . . "T" Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31 and No. 35†.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

FLUXES

*INCO Gas Welding and Brazing Flux for Monel Metal.
** "Cromalloy" Gas Welding Flux is recommended for Inconel.
† For vertical welding.
No flux is used for the gas welding of Pure Nickel or Nickel-Clad Steel.

INCO welding materials as listed can most conveniently be obtained through regular INCO distributors.
Detailed welding instructions furnished on request.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

The Welding Engineer

VOLUME 19 | AUGUST, 1934 | NUMBER 8

Welding and Cutting for Maintenance

in the Electric Light and Power Industry

By D. D. DeTROW

Welding Operator

A HUGE investment in capital is represented by the shops and tools used by the electric light and power industry to maintain and repair existing facilities so that efficient service is always available to the consumer, at the pushing of a button or the throwing of a switch.

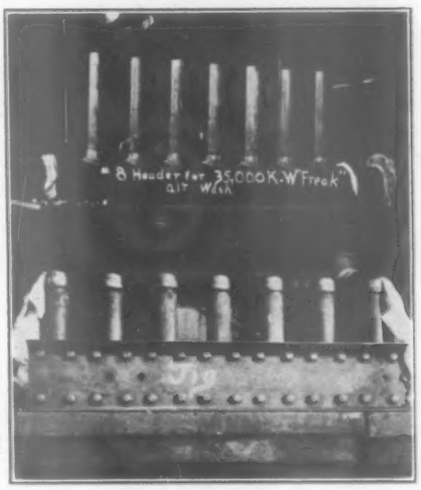
Welding meets with much favor in present-day power plants. The following examples are but a few of the many instances where cutting and welding have served to effect speedy, economical repairs in one of the large power stations in the Middle West.

Pipelines. — When service lines, whether water, oil, or steam, become worn and require replacing, templates are made of existing lines and these are used to fabricate new lines in the shop, with all branches and fittings welded. The entire assembly is installed after peak hours, when the load is light and the old line can be taken out of service.

Expansion Joints.—Spun copper expansion joints for exhaust steam lines suffer from excessive travel and become work-hardened, then crack at the lapped edges. These cracks are silver soldered with a No. 6 alloy, then annealed, which restores the initial elasticity.

Ash Dump Pans.—Hinge pieces for boiler ash dump pans, formerly of cast iron, are now made of stock shapes of rolled steel, cut with the oxyacetylene torch and entirely arc welded. The cost of materials and labor to fabricate is less than two-thirds of the cast-iron type. In three years only one welded hinge has failed. The greatest service expected from a cast-iron hinge is six months. Small pipe, arc welded to the steel structure, eliminates drilling and clamps, and speeds up the work.

Soot Ejectors.—Soot ejectors of the vacuum type, made of high-carbon triple-chilled cast iron, can be welded with the oxyacetylene torch. Worn spots, imperfect steam jets, broken lugs and target plates no longer keep the equipment out of service.



Completed Welded Header (Above) and Assembly Jig (Bottom).

(Six of these all-arc-welded headers were fabricated on the jig shown, and all spray racks were also welded, the racks and headers being used in conjunction with an air-wash system for a 35,000-kw. turbine-generator.)

Soot-Blower Tubes. — Heat resisting soot-blower tubes for large-capacity boilers contain 25% chromium and are very costly. These tubes can be successfully welded with either the oxyacetylene torch or the metallic arc.

Pump Head. — A 20,000-kw. turbine was taken out of service, the steam condensate pump shut down and the discharge or exhaust valve closed. Unknown to the operator, the throttle valve leaked, the exhaust valve was tight and a small safety release valve failed to function. As a result, the cast-iron pump head gave way, breaking into eleven pieces. There was no spare for replacement, so the only solution was to weld. All eleven pieces were carefully chamfered and fitted together, then lightly tack welded, after which the assembly was carefully preheated and welded. A slow cooling followed, and the following morning a careful check showed the casting to be out of true less than 0.017 in. This pump has been in operation, since repair, for four years without failure.

Pump Governors.—A governor for a steam-condensate pump of a 25,000-kw. turbine, failed and burst its casing into nine very irregular fragments. Welding was applied, and four hours after the accident the governor again was functioning regularly. Welding can be readily applied to horizontal, unbalanced, piston-type pump-governor valves, which are readily built up with a special manganese bronze which will wear as well as the original surface and is easier to apply.

Throttle Valve. — A master throttle valve of a 30,000-kw. turbine developed a serious steam leak. Inspection revealed 14 deep steam scores beneath the seat ring. These worn places were cleaned and then filled with a No. 6 alloy silver solder. The turbine was out of service for only six hours.

Turbine Blades and Diaphragms. — Many of the low-pressure-stage blades and diaphragms of a 30,000-kw. turbine were badly damaged by a foreign object which found its way into the turbine. All diaphragms were repaired with silver solder applied with the oxyacetylene torch, and the blades were straightened and silver soldered into place.

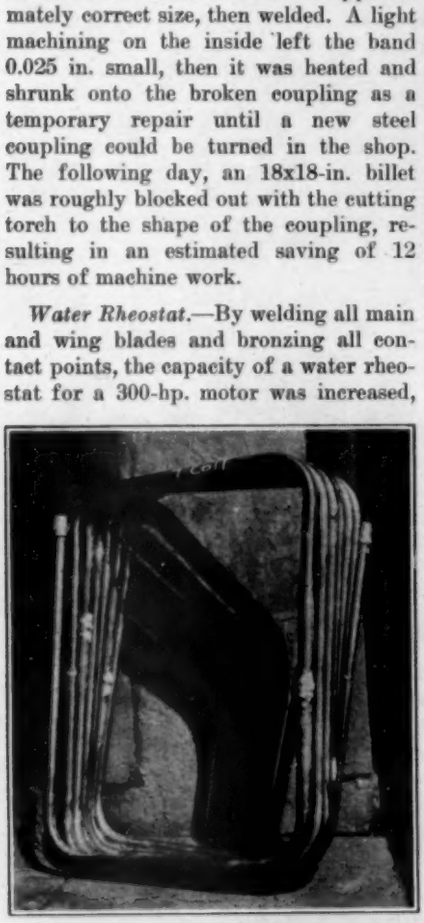
Transfer Table.—In attempting to use a transfer table at a new substation to move into place a spare 66,000-volt transformer which was to replace one that had just blown out, it was discov-

ered that the rails had not been cut to proper length, thus preventing the table from being placed in alignment. Work was at a standstill for a short time until an oxyacetylene cutting torch was secured and an inch removed from the end of each rail.

Brush Lifter.—A cast-iron hinge piece on a large rotary converter, by which all the brushes, save the pilots, are raised, was broken while being removed from service. The hinge was cast integral with the main body. An immediate repair, by bronze welding, without dismantling, made it possible to put the converter back into service without danger of burning the commutator or bucking the line frequency.

Motor Coupling.—The coupling of a 500-hp. motor had burst into several pieces and was quickly restored to service by applying a shrink band made from 1x3-in. material rolled to approximately correct size, then welded. A light machining on the inside left the band 0.025 in. small, then it was heated and shrunk onto the broken coupling as a temporary repair until a new steel coupling could be turned in the shop. The following day, an 18x18-in. billet was roughly blocked out with the cutting torch to the shape of the coupling, resulting in an estimated saving of 12 hours of machine work.

Water Rheostat.—By welding all main and wing blades and bronzing all contact points, the capacity of a water rheostat for a 300-hp. motor was increased,



Copper Cooling Coil for Water Rheostat.
(Consists of three lengths of copper pipe, all joints brazed and fittings on ends also brazed. Coil made on a small turntable with adjustable corners. Heated with an oxyacetylene torch before bending at corners.)

the life of the blades lengthened sixfold, and heating reduced, thus evaporating less water and resulting in a more stable solution.

Equipment for Testing. — Thermocouples for determining furnace temperatures, water-cooled gas samplers,

Water-Rheostat Blades.
(Wings and top angles are welded. Tops are brazed at contact points to reduce contact resistance and heat.)

solid sampler chambers for testing solids in flue gases, and special draft fittings are quickly welded up from rough sketches, to expedite boiler tests. An Illium Parr calorimeter bomb, used in the laboratory for making B t u. tests, was quickly repaired by welding, making it possible to rush through a special job of coal analysis. The welding of electric filaments, 0.015 in. and over, the perfect union of thermocouple wires, the welding of special alloys and chemical-resisting metals, allow the laboratory and Results Department a very wide range in the devising of special equipment.

Structural Tower.—To speed up the removal of a 70-ft. transmission tower from the right-of-way of an interurban line, the oxyacetylene cutting torch was employed to fall and cut the tower into small sections, all accomplished in three hours' time.

Draw Bar.—A locomotive cast steel draw bar was broken in a section 5 in. thick. The draw bar was welded and reinforced, thus making it stronger than in its original state. The locomotive, used in the yards for handling coal and ashes, was out of service only five hours.

Rails.—Two large electric locomotives were having much trouble with burnt or pitted contactors, heating of the motors, and a general sluggishness of action. The entire track system was gone over, and all rail joints were carefully bonded, all frogs and switch points were likewise attended to, and all tracks were cross bonded at frequent intervals. Since bond maintenance has become a part of track maintenance, four years have passed without any of the former troubles appearing. Contactors, resistors, motors, and allied equipment have been trouble free. Worn frog and switch points are also built up in service and require no grinding or machine work. A carbon steel rod is used as filler and is tempered with a reducing oxyacetylene flame.

It will be noted, in many of the examples given, that time out of service is the deciding factor in choosing welding for maintenance and repair. This factor, together with the economy of the process, makes welding a valuable tool for the modern power plant.

Tentative Program for A. W. S. Fall Meeting

A wide variety of timely topics are listed on the tentative papers program for the fall meeting of the American Welding Society, to be held at the Hotel New Yorker, New York City, Oct. 1st to 5th. Technical sessions will be held at 2:30 p. m. on Oct. 1st and at 9:45 a. m. and 2:00 p. m. on the other days. The presentation of the Miller Memorial Medal will be made at 2:00 p. m. on Oct. 1st, and the dinner meeting of the Board of Directors will be held at 6:30 p. m. of the same day. At 7:30 p. m. on Oct. 2nd will be held the conference and meeting of the Fundamental Research Committee, American Bureau of Welding, and the annual banquet will be held at 7:00 p. m. on Oct. 4th, in the Hotel New Yorker.

The papers program includes addresses on the welding of structural steel and piping, including designing and testing. Also, peening, testing for physical properties, welding of cast iron and alloy steels, silver solders, hard facing, metal spraying, flame cutting, application to railroad track maintenance and rolling stock, alternating-current welding, qualifying and testing operators for welding various types of structures, and welding in engineering education, are among the topics to be discussed.

The final draft of the program will be published complete in the September issue of *The Welding Engineer.*

Concurrently with this meeting will be held the National Metal Exposition in the Port Authority Building at 14th and 8th Aves. Already this show, in the amount of space taken, is 30% larger than last year, reports W. H. Eisenman, director.

Welding Bronze Rollers to Cast Brass Heads

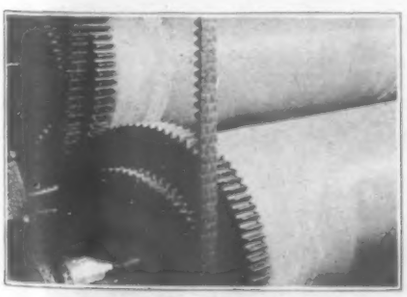
By W. J. CHAFFEE
The Hobart Brothers Co.

One of the products of The Specialty Papers Co., Dayton, Ohio, is paraffin-coated paper, such as is used for wrapping loaves of bread. As soon as the paraffin has been applied it must be hardened so that the layers of coated paper will not stick together when it is immediately run on to the final rolls.

The paraffin is hardened by chilling, which is accomplished by running the coated paper over two revolving cylinders containing a liquid refrigerant, one cylinder contacting one side of the paper and one the other side. Since this liquid costs about 40c per gallon, Mr. Gano, chief engineer of the company, was naturally eager for quick and effective action when it began to leak at the ends of the cylinders, getting away at the rate of 50 gallons per day.

The cylinder barrels are 3 ft. in diameter, more than 6 ft. long, and made of $\frac{5}{8}$ in. bronze (90% copper, 10% tin). The heads are of cast brass (75% copper, 10% tin, 15% zinc), $\frac{7}{8}$ in. thick, studded to inner rings, which are riveted to the barrels at the ends. It was found impossible to keep the joints tight by replacing gaskets, so welding or brazing seemed to be the only relief. It was out of the question, however, to shut the apparatus down for three days, as would have been necessary in order to remove the cylinders for ordinary welding or brazing practice.

Arc welding solved the problem. By the Hobart "Long Arc" process with "Hobronz," described for the first time in the Sept. 1933 issue of *The Welding Engineer*, the heads were arc welded to the barrels without removing the cylinders, with a shutdown of only ten hours



These Cylinders Were Welded in Place by the "Long-Arc" Method.

and with a cash outlay of only $45 for the company.

The gears at one end of each cylinder were merely loosened and moved slightly away from the heads but left on the shafts. The cylinders were turned by a helper so that the welding operator could weld always in the "down" position. Actual welding thus required only four hours for the 38 lineal feet of welding on all four ends. Ten pounds of $\frac{1}{4}$ in. "Hobronz" were used, with a Hobart diverter-pole-type welding machine, providing 350 amperes at 50 volts across the arc. The space between the heads and the barrels (about $\frac{1}{8}$ in.) was not V'd and no preheating was done. It was found desirable to "weave" the bead from side to side, making the weld about 1 in. wide.

No leaks developed under the initial

The Weld Bead Was "Weaved" Over a Width of One Inch.

test and the cylinders have now been in practical operation for approximately five months without leaks. The job was handled by Robert Bercaw, of The Hobart Brothers Co., and was witnessed by a number of job welders in the vicinity, as a practical demonstration of a new arc-welding technique.

Activities Regarding the National Association

Henry Malek, of Cedar Rapids, Iowa, recently spoke at Waterloo, Iowa, and Moline, Ill., in the interest of the National Association of Welding Contractors, Inc., of which he is a director.

Dale S. George, president of the association, recently made talks in Rock Island, Ill., to the Tri-City group, and also visited the convention of the horseshoers and blacksmiths at Fort Dodge, Iowa, at which he learned that 85% of the blacksmith shops in Iowa do electric or acetylene welding. Several members of their association became members of the National Association of Welding Contractors, Mr. George reports. Wm. L. Allan, of Ames, Iowa, president of the horseshoers' and blacksmiths' association, is an active member of the National Association.

An association in the cities of Davenport, Iowa, and Rock Island and Moline, Ill., known as the Tri-City Association, has been formed, says Mr. George, with Art Gustafsen as president and A. A. Lehne secretary. This association is a member of the National Association.

Effort is being made by A. Keogh, of the Sound Welding Co., and Ralph Stark, Inc., to bring all five boroughs of Greater New York into the National Association.

However temporary the NRA and the code structure may be, the National Association is a permanent institution, says Mr. George, who takes every opportunity to urge everyone in the welding business to help stabilize prices and retrench the credit structure of the industry through working with the national group.

Uses Pyrene in Oil Barrels Before Welding

In making repairs by welding on barrels or tanks that have held oil or gasoline, Emil Tedin, job-shop owner of Oakes, N. D., eliminates the danger of explosion by shooting liquid from a fire-extinguisher unit into the vessel prior to welding. His method is to remove the bung, flush with water, shoot Pyrene into the vessel (one shot is enough in the case of oil barrels), then weld, and finally reflush with water, after which the vessel is left to dry out. In the case of gasoline tanks, it is important to remove all the Pyrene liquid by flushing, otherwise it may give carburetor trouble.

At its best, the welding of such containers is a dangerous thing, unless the welder exercises due precaution. The use of Pyrene, carbon dioxide, or other gases or liquids, other than steam, is not strictly orthodox, yet many containers of inflammable fluids have been welded and cut safely by the intelligent use of such media. In the case of Pyrene, if too much of it is applied, the welder will have difficulty in keeping his torch lit, Mr. Tedin reports.

Launches All-Welded Motor Tanker

The all-welded motor tanker *Poughkeepsie-Socony* was launched on Aug. 3rd at the Staten Island, N. Y., plant of United Dry Docks, Inc. This is the third vessel to be built recently for the Socony-Vacuum Oil Co., the former two being of riveted construction. It is said that the company will build several more welded ships, claiming economy in first cost and lighter weight for the riveted vessels. The *Poughkeepsie-Socony* is 260 ft. long overall, with 40-ft. beam and 14-ft. depth, and has a capacity of 712,500 gallons.

Has the Insurance Man Changed His Mind ?

"No. We wouldn't insure unsafe welding twenty years ago and we won't insure it today," replies Mr. Halsey.

An Interview by H. S. CARD with W. D. HALSEY, Assistant Chief Engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Connecticut

ILLUSTRATIONS BY CHICAGO BRIDGE & IRON WORKS

IN THE not very distant past, insurance companies were rather consistent about turning thumbs down on welded boilers and pressure vessels, thereby incurring the wrath of many a staunch advocate of welded construction. Now, for the past several years, fusion-welded vessels have been accepted for insurance. More than that, this approval of good welding has been featured in insurance advertising.

It would be easy for the welding enthusiast to jump to the conclusion that the insurance man is seeing the light at last, and has experienced a change of heart. Let's not be so hasty. It is important to know whether the point of view of the insurance man has actually changed. In fact, it is important to know at this time just what that point of view really is.

Accordingly, the writer sought an interview with Mr. Halsey, whose company has been the leader in the campaign to induce welding shops to adopt practices that will produce safe welding. The writer attempted to include all the questions of the welding industry in a single hypothetical question, which is too long to be repeated here. It is Mr. Halsey's answer that counts.

"Nothing could explain our viewpoint better," he said, "than the story of our experience. As we go along you will see that we have not changed heart. We wouldn't insure unsafe welding twenty years ago and we won't insure it today.

"It was no spirit of antagonism which kept us from insuring welded boilers and vessels ten years ago. The fact is that we were continually coming into contact with accidents caused by bad welding, and the evidence was plentiful. We knew that good welds could be made, but we had no adequate check on workmanship at the time; and knowing the disastrous effects of some of the poor welding, we could take only one position — not to allow the use of fusion welding in any place where a weld failure could result in appreciable damage.

"No doubt this viewpoint seemed both arbitrary and incomprehensible to the man who was always prepared to make a weld which would break in the plate. Such a test is not conclusive, yet it was the one most frequently used in urging us to change our attitude.

"During this period efforts were also being made to secure a revision of that part of the A. S. M. E. Boiler Code which pertained to the use of fusion welding in the construction of unfired pressure vessels, and some very expensive tests were made for this purpose. But the time had not arrived.

Manufacturers Proved Reliability of Welded Boilers

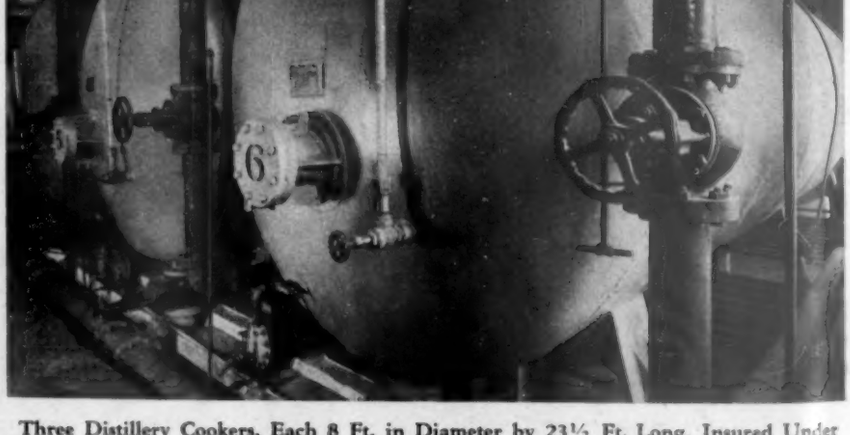
"Then came a period when a few of the larger boiler manufacturers began to produce welded boiler drums and pressure vessels which were really safe. These manufacturers were able to demonstrate the safety of their construction methods, and to obtain insurance on their products. Of course they were exceptions, and it was natural that other concerns in the same line of business should ask 'What must we do to obtain approval for *our* products?' This was a fair enough question, and I think that the efforts which Hartford Steam Boiler put forth to answer it show clearly enough that our viewpoint has been fair to fusion welding right along.

"Our great difficulty was the complete lack of standards. We were perfectly willing to approve safe construction, but none of the conventional weld tests showed this in a suitable manner. So we had to work out our own test standards.

"Tensile coupons which broke outside the weld did not tell us what we wanted to know, which was, the strength of the weld itself. So we designed a reduced-section tensile specimen which breaks in or at the weld, and gives us that information.

"Ductility being an important factor, we adopted the free bend test for ductility which was developed by S. W. Miller in the Union Carbide and Carbon Research Laboratories.

"But there remained one more vital point to be investigated—the *soundness* of the weld metal. Gas pockets and slag inclusions set up stress concentrations



Three Distillery Cookers, Each 8 Ft. in Diameter by 23½ Ft. Long, Insured Under Requirements of A. S. M. E. Class 2 Vessels.

All-Welded Butane Tank, 10 Ft. in Diameter by 40 Ft. 3 In. Long, 160-Lb. Working Pressure, Insured Under A. S. M. E. Class 2 Requirements.

which may lead to failure, and these imperfections may not be disclosed in the tests for tensile strength and ductility. Our answer to this part of the problem was the development of the nick-break test, which opens the inside of the weld for inspection.

"The nick-break test is the least expensive of the three, but it is by no means the least important, and it reveals a surprising picture of the inside of a weld.

"Of course, the most satisfactory method of examining a welded joint for soundness is to have it x-rayed and this kind of examination is required by the A. S. M. E. Code for power-boiler drums and for certain other types of pressure vessels. For other vessels, however, we proceed on the theory that sound welding depends on a proper technique of welding, and on welders trained to follow that technique and then tested to know they can obtain the desired results. The three tests outlined above give us a good method of examining the ability of a welder.

Steps for Obtaining Approval of Product

"The routine of their application is briefly this: The manufacturer of the welded article must first demonstrate that his process will produce welds which pass all of these tests satisfactorily; next he must qualify each welding operator who is to work on any insured vessel; if any change in procedure, or technique or materials is made in the shop, it is necessary to demonstrate that such changes will still produce acceptable results. The reason for this is that the insurance company is interested primarily in the safety of the final result. This safety depends upon the process used and upon the workmanship of the man using it.

"This is a greatly abbreviated and simplified story of the development of the 'Hartford Tests.' It shows, however, that we have fully appreciated the advantages of welded construction and have actively cooperated with manufacturers who want to use such construction —to the end that the result be insurable!

"When the A. S. M. E. Boiler Code was finally revised to permit greater use of fusion welding in the construction of power-boiler drums and unfired pressure vessels, the resulting Code closely paralleled our own requirements, and we have adopted that Code as our recommended standard of construction. Copies of the Code are readily obtainable and should be consulted for detailed information as to what constitutes 'insurable welding'."

Insurance Men Interested in Results Rather Than Means

Here is an obvious determination to approve only what is known to be safe. In the discussion, reference has been made to process and procedure. The manufacturer who has been welding for a number of years quite naturally thinks that he has mastered the process and wonders whether the insurance company will try to revise his methods or make him adopt new ones. So the writer questioned Mr. Halsey on this point.

"It makes no difference to the insurance company," was the reply. "Our interest is entirely in the result. There has been much misunderstanding on this subject. It is necessary, of course, to examine the design of the job, to be sure that it is a safe design. Then we examine the welding procedure and satisfy ourselves that it is, and will continue to be, uniformly applied. And finally we must ascertain by the prescribed test methods whether such procedure will yield the specified results. In many cases we find the idea prevailing that we expect to dictate how the welding should be done. But it is not our place to do that. If our tests show that the manufacturer's procedure does not produce welds that are up to our standard of quality, then he must revise his procedure, but *how* he revises it is up to him. He may be able to diagnose and cure his own trouble after seeing the tests, or he may have to obtain the services of a consulting engineer.

"The most gratifying reaction has been found among executives of concerns who have made application for approval, and have taken the steps necessary to secure it. They usually tell us frankly that the experience has been worth what it cost, in improving the product and increasing the efficiency of the plant. There is no question about the correctness of this, because haphazard methods and H. S. B. approval can scarcely exist in the same plant."

Mr. Halsey's company has prepared an illustrated booklet describing the "Hartford Tests" in detail. Those who are interested in good welding practice will find much of value in this booklet as well as in the revised A. S. M. E. Boiler Code.

Advanced Course in Welding Engineering

A special 5-day course in welding engineering is being offered at intervals by The Lincoln Electric Co. and the John Huntington Polytechnic Institute, both of Cleveland, working in conjunction with each other. This course runs from Monday to Friday, inclusive. From 10:30 a. m. to 4:30 p. m. each day, talks, demonstrations and practical work are given in the plant of The Lincoln Electric Co. at 12818 Coit Road. From 7:30 p. m. to 9:30 p. m., lectures are given at the John Huntington Polytechnic Institute, 3133 Euclid Ave. The fee for the course is $10, which includes demonstrations and work at the plant and the lectures at the Institute.

This course was first given the week of July 23rd, and will also be offered beginning on each of the following dates: Sept. 17th, Oct. 15th, Nov. 19th, Dec. 17th, Jan. 7th, 1935, Feb. 11th, Mar. 18th, Apr. 15th, and May 20th.

It is pointed out that this course is not intended to train welding operators, but to give engineers and welding supervisors and foremen a practical and theoretical coverage on the subject of welding engineering.

The course will cover the following subjects: value and use of the shielded arc; calculation and distribution of stresses in welded joints; study of polarized-light and rubber weld models; penetration; designing for arc welding; organization of welding departments and estimating welding costs, and related topics.

Evolution of Welding-Generator Design—I

First of a Series of Three Articles

■ By K. L. HANSEN
Consulting Engineer, Harnischfeger Corp.

IN THESE three articles, Mr. Hansen discusses the theory of the welding generator in terms that the reader who is grounded in the elements of electric circuits may readily understand.

THE analytical and the experimental method both have played an important part in the development of the present-day arc welder. The former, however, predominates, since the expense of the development of a machine, generally speaking, is in inverse proportion to the extent to which the analytical method can be applied.

In this series of articles will be described the changes that have taken place in design of arc-welding generators since their introduction, whether they be the result of analysis or experiment.

Before any serious attempt was made to apply the electric arc to welding, it had been used to a considerable extent for lighting purposes. From the experience gained with the arc in this field, it was known that it differs widely from ordinary metallic conductors in that it possesses a negative resistance characteristic.

This means that if the current in the arc for any reason should increase slightly, the resistance of the arc decreases, and if the voltage across the arc is maintained constant, the current will continue to increase, which in turn still further reduces the resistance, and this action is cumulative so that enormous values of current will be reached in a short time. On the other hand, if for any reason the current in the arc should decrease slightly, the action is precisely the reverse, and the current will be reduced to such values that the arc goes out.

This is known as the inherent unstable characteristic of the arc, and it is because of this characteristic that the arc cannot be operated from a source of constant voltage without some stabilizing agent in the circuit.

Using Series Resistance to Stabilize the Arc

The usual method of stabilizing the arc when it is operated from a source of constant voltage is to insert a resistance in series with the arc. Then, when the current in the arc increases, the voltage drop across the resistance also increases. That reduces the voltage across the arc, and offsets the reduction of arc resistance which accompanies any increase in arc current. The action, of course, is the reverse when the current in the arc decreases, in which case the rise of voltage across the arc offsets the increase in arc resistance which accompanies any reduction of arc current.

In the early days of arc welding, it was quite common practice to use a standard line of 110 or 220 volts and insert a resistance to reduce this voltage to arc voltage. However, the extreme inefficiency of such a system will readily be seen. For example, in the case of a 220-volt line, 200 volts would be lost in the resistance in order to reduce the voltage to 20 volts, which is the average arc voltage when using bare electrodes; that is, ten times as much heat would be wasted in the resistance as would be actually utilized in the arc. It is obvious that, except for extremely intermittent service, the cost of operation of such a system would be prohibitive and would preclude its use for any kind of production work.

The increasing use of arc welding made the demand for more efficient apparatus imperative. The next step was to build generators designed to operate at a lower voltage than the standard power and lighting potential. Constant-potential welding generators therefore were developed to operate at 70 or 75 volts, though otherwise these did not differ in design from lighting or power generators.

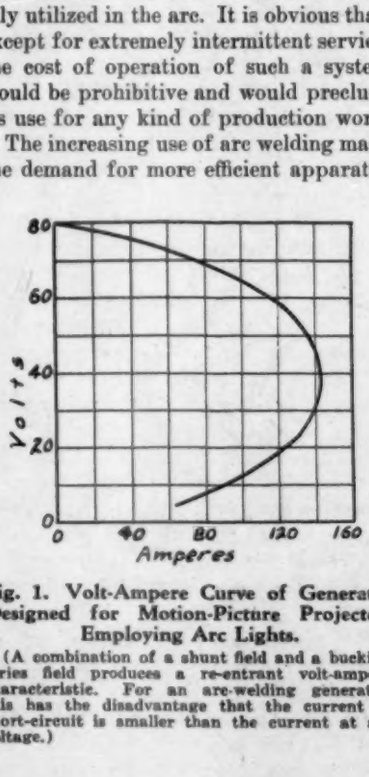


Fig. 1. Volt-Ampere Curve of Generator Designed for Motion-Picture Projectors Employing Arc Lights.

(A combination of a shunt field and a bucking series field produces a re-entrant volt-ampere characteristic. For an arc-welding generator, this has the disadvantage that the current at short-circuit is smaller than the current at arc voltage.)

Early Constant-Potential Generators

As these generators operated at constant voltage, a stabilizing or, as is commonly called, ballast resistance, had to be inserted in series with the arc. It was, however, possible to operate a number of arcs from the same generator, provided a ballast resistance was inserted in each arc circuit. A ballast resistance is usually made up of a number of units which may be connected in various series and parallel combinations, allowing an adjustment of welding current in a comparatively limited number of rather wide steps. With such a system, the current adjustment necessarily is coarse and requires an elaborate system of switches.

One of the earliest installations of a constant-potential arc-welding motor-generator set was at the Chester Steel Casting Co., Chester, Pa., which set was put into service in April, 1905. This set was built by the C. & C. Electric Co., which some years ago was acquired by the Burke Electric Co., of Erie, Pa.

While the constant-potential welding generator was an improvement over the earlier system from the standpoint of efficiency, it still left much to be desired. The energy wasted in the ballast resistance was out of proportion to the energy usefully expended in the arc itself. The system, furthermore, lacked the flexibility of the later-developed individual-operator welding generator, though it had an advantage in that the generator could be used as a multiple-operator machine.

One disadvantage of the multiple-operator system, which is often overlooked, is that the arcs are not entirely independent of one another. When one operator strikes his arc, there is a momentary effect on the arcs which are already in operation from the set, and the same is true when one of the operators breaks his arc.

Naturally, efforts were soon directed towards elimination of the wasteful ballast resistance and introduction of finer current adjustment. These efforts led to the development of the individual-operator arc-welding generator.

It was apparent to designers that if the ballast resistance were to be eliminated, the generator must have an inherent volt-ampere characteristic somewhat

similar to that produced by a constant-potential generator in combination with a ballast resistance. The necessary requirement to overcome the inherent arc

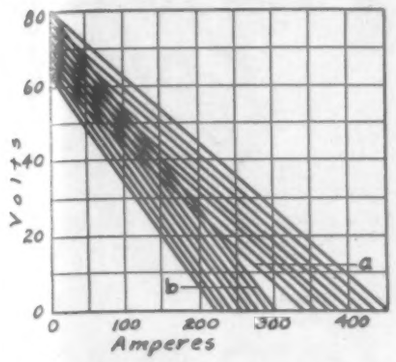


Fig. 2. Volt-Ampere Curves of a Welding Generator Having a Separately Excited Field With a Bucking Series Field.

(By inserting various steps of resistance in series with the separately excited field, a series of volt-ampere curves are produced, all having the same slope. Shunting part of the bucking series field increases the slope of the set of curves, but the open-circuit voltage remains unchanged. Thus the welding current is reduced, but at the same time the voltage is maintained high enough so the arc is easily struck and maintained.)

instability is a drooping volt-ampere characteristic; that is, the voltage should drop rapidly with increasing current.

Designing for a Drooping Volt-Ampere Curve

The obvious method of obtaining a drooping volt-ampere curve from a generator is to supply it with a differential or bucking series field. This is merely reversing the well-known practice of supplying a generator with a cumulative series field when it is desired to maintain a constant or slightly increased terminal voltage with increasing load.

Some experience had been gained in operating arcs from differentially compounded generators in connection with arc lights for moving-picture projectors. Generators designed for this service were supplied with a self-excited shunt field and differential series field. The volt-ampere curve of a machine of this type is shown in Fig. 1.

It will be noticed that the current increases with decreasing voltage, reaches a maximum, and then decreases again as zero voltage, or short-circuit, is approached. This is known as a re-entrant volt-ampere characteristic, and it will be observed that the current on short-circuit is less than the current at arc voltage. The re-entrancy is due to the fact that the terminal voltage which furnishes the excitation for the shunt winding steadily decreases and becomes zero at short-circuit.

While a generator of this type proved entirely satisfactory for operating an arc light, it was soon discovered that it did not have a volt-ampere characteristic suited to a welding arc. Because of the fact that, in welding, the arc is short-circuited at frequent intervals, the re-entrant volt-ampere characteristic proved undesirable. The short-circuit current should be at least equal to, and preferably greater than, the welding current.

Characteristics Improved by Separate Excitation

To fulfill this condition it became necessary to have a source of excitation which would be maintained on short-circuit, when the terminal voltage is zero. A straight shunt winding excited from the terminals obviously fails to accomplish this. The first solution naturally to present itself for overcoming this difficulty was to supply the shunt winding from a separate source of excitation. This required the use of a small separate generator to be used as an exciter. Thus emerged the earliest type of individual-operator welding generator equipped with a separately excited field and a differential or bucking series field. The volt-ampere characteristic is shown in Fig. 2.

By inserting a variable resistance or rheostat in the separately excited field circuit, it becomes possible to adjust the welding current. A variation of this resistance from point to point gives rise to a set of substantially parallel volt-ampere curves, as indicated by the group marked *a* in Fig. 2. It will be seen that when the welding current is varied by means of a rheostat in the separately excited field, the open-circuit voltage is varied simultaneously with the welding current.

It is evident that if the welding current is to be reduced to a low value by this means, the open-circuit voltage also becomes greatly reduced, which makes it difficult to strike and maintain the arc. To overcome this undesirable effect, various schemes were devised whereby the de-magnetization of the bucking series field could be varied in two or more steps. These methods consisted in shunting part of the current from the series field by an adjustable resistance, or by bringing out taps from the series field.

Effect of De-Magnetizing Part of Series Field

The effect of increasing the de-magnetization of the series field is to give rise to another set of substantially parallel volt-ampere curves of greater slope or steepness than the set *a*, as indicated by the set *b* in Fig. 2. By varying the rheostat as before, the same set of open-circuit voltage values will be gone over, but a set of lower welding currents will be obtained.

This scheme is often referred to as dual control, or independent voltage and current control, and was devised solely for the purpose of obtaining a wide range of welding currents without reducing the open-circuit voltage to the extent of making it difficult to hold an arc.

Combining Fields to Obtain Simplified Control

A method of accomplishing the same thing with one control is not only as good, but is simpler. By adding a self-excited field to the separately excited field, the curve shown in Fig. 1 is superimposed on the curves shown in Fig. 2, giving the volt-ampere curves shown in Fig. 3, the shapes of which may be altered by changing the proportions of the self-excited field. With this arrangement, it is possible to obtain a wider range of welding currents for a given variation of open-circuit voltage than is possible with a straight separately excited machine, without resorting to change in the de-magnètization of the series field.

Some ten to fifteen years ago the battle waxed hot and heavy as to what constituted the most desirable shape of a volt-ampere curve for arc welding. There were constant-energy advocates; others favored constant current; others variable voltages, etc. This battle has to a great extent subsided as experience has definitely shown that the so-called transient performance, which will be discussed later, greatly overshadows the shape of

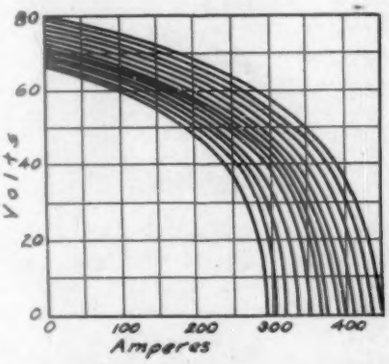
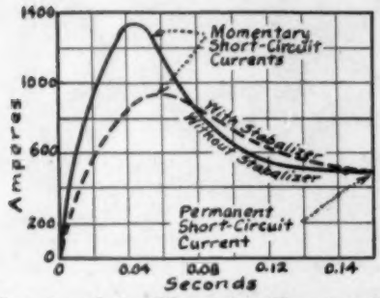


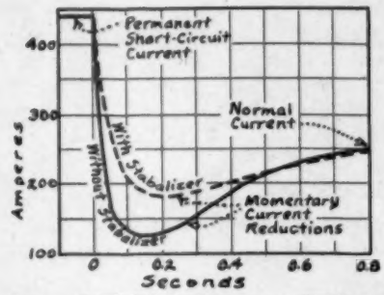
Fig. 3. Volt-Ampere Curves of a Welding Generator Having a Self-Excited Shunt Field, a Separately Excited Field, and a Bucking Series Field.

(These curves are a combination of the curves shown in Figs. 1 and 2, and show how it is possible to obtain various values of current, with high open-circuit voltages, merely by varying the resistance in series with the separately excited field.)

the volt-ampere curve in importance. The requirements of the volt-ampere curve are: (1) that the open-circuit voltage be sufficiently high to readily strike the arc; (2) that the curve be drooping fairly rapidly anywhere over the welding ranges; and (3) that the short-circuit current exceed the welding current by at least 25%.

It will be seen from the curves in Figs. 2 and 3 that as the resistance varies from infinite resistance on open-circuit to zero resistance on short-circuit, the current increases and the voltage decreases, following the volt-ampere curve, until on





Figs. 4 and 5. Illustrating Transient Performance of Welding Generator, With and Without a Stabilizer.

(Fig. 4, at the left, shows the overshoot of current that occurs when the terminals of the generator are suddenly short-circuited. Fig. 5, at the right, illustrates the momentary current reduction that takes place when a resistance is suddenly inserted into the circuit. The effect of the stabilizer is to reduce the peaks of the fluctuations, but to increase the time of readjustment.)

short-circuit the terminal voltage is zero and the current is maximum.

However, it is only for a comparatively slowly varying external or load resistance that the current varies in this manner. The volt-ampere characteristic of a machine is obtained by loading it on a resistance, and observing the volts and amperes. The resistance is then varied, and voltage and current are again observed after they have settled to steady values following the change in resistance. These curves, therefore, tell us nothing about the performance of the machine during the period of readjustment when the resistance is changed from one value to another. They simply show the steady values of current and voltage for different values of external resistance, and are often referred to as the "static volt-ampere curves."

Behavior of Machine During Readjustment Period

However, the performance of a generator during periods of readjustments of external resistance values is of great importance in arc welding, because the resistance of the arc is varying rapidly and continuously. The behavior of the machine during the period of readjustment is referred to as the transient performance, and is of very great importance. We have heard a great deal lately about current recovery, voltage recovery, overshoots and undershoots, etc. These are all simply various phases of the "transient performance."

This phase of the subject is so important that it might be well to consider it more specifically. Consider, for example, a machine having volt-ampere characteristics as shown in Fig. 2, so adjusted as to give the extreme right-hand curve of the group marked *a*. The open-circuit voltage is 80 and the short-circuit current is approximately 440 amperes.

Now, when the terminals are suddenly short-circuited, the current does not simply rise to 440 amperes and stay there. It will overshoot this value to a greater or less degree and then settle at 440 amperes. The reason for this is as follows: In order that the current should instantly attain its final value, the terminal voltage should instantly drop to zero. That means that the magnetic field on which the terminal voltage depends should instantly be reduced to a value corresponding to zero terminal voltage; it cannot do so without having a high voltage from an external source impressed upon it, because, in common with a moving mass, an electromagnetic field possesses inertia —that is, it opposes any tendency to change. The reduction in the magnetic field of the machine, and therefore the reduction in terminal voltage, lags behind the reduction in external resistance, and, as a result, there is a momentary excess of voltage.

Momentary Current Fluctuations

This excess of voltage produces a momentary overshoot of current before it settles down to the short-circuit current. This is graphically demonstrated in Fig. 4. It might be mentioned that the ratio of momentary short-circuit current to permanent short-circuit is an important item in the U. S. Navy specifications for arc welders.

On the other hand, when a resistance is suddenly inserted in the circuit, the reverse action takes place. In that case, the voltage cannot instantly build up to the required value, so there is a momentary deficiency of voltage, which causes the current momentarily to drop below the final or steady value.

For example, consider the same conditions as before, except that the machine is short-circuited and delivering a current of 440 amperes. Suppose now, a resistance of 0.144 ohm is suddenly inserted in the circuit. That, according to the volt-ampere curve, means an output of 250 amperes at 36 volts. However, because the voltage cannot instantly rise to 36 volts, the current momentarily dips below 250 amperes to a greater or less extent. This is graphically demonstrated in Fig. 5. The dip below normal current incidental to the insertion of a resistance in the circuit also figures conspicuously in the Navy specifications.

Development of the Stabilizer

In arc welding, it is very essential that these momentary current fluctuations incidental to wide and rapid changes in the external resistance be kept within comparatively narrow limits. Here is where the stabilizer comes in. In its early form, the stabilizer consisted of a coil of heavy wire or straps wound on a laminated magnetic circuit, which might be closed or have an air gap. The coil was connected in series with the arc circuit; that is, it constituted simply a choke-coil or inductance. Its function was to store energy when there was an excess from the machine and return energy when there was a deficiency. The action, therefore is analagous to that of a fly-wheel on a moving mechanism. By its action, the stabilizer helps to smooth out the current fluctuations as shown by the dotted curves in Figs. 4 and 5. It will be observed that the stabilizer reduces the peaks of the fluctuations, but increases the time of readjustment.

This form of stabilizer is still used to some extent, but has undergone considerable modification in most modern machines, which will be described later.

The early form of single-operator welding generator described may be represented diagrammatically as in Fig. 6. The differential series field may or may not have an adjustment to widen the range of welding currents. In some makes of machines a self-excited field was added to modify the volt-ampere curve.

Accidental Reversal of Polarity

An interesting and sometimes annoying feature of this system was its susceptibility to accidental reversal of polarity. A reversal of polarity may be produced by simply lifting an exciter brush and replacing it on the commutator. The reason for this can readily be appreciated by observing the diagram. Suppose a brush is lifted so that the circuit is broken at *a*. This causes the currents

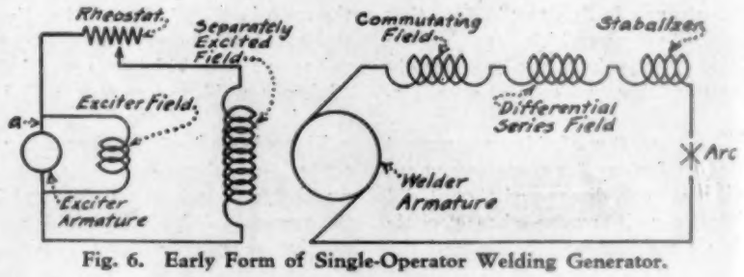


Fig. 6. Early Form of Single-Operator Welding Generator.

in the generator and exciter fields to die out; and as the energy stored in the generator field greatly exceeds that stored in the exciter field, it sends a momentary reversed current through the latter. This causes the residual magnetism of the exciter field to become reversed so that, upon replacement of the brush, it will build up in the opposite direction and reverse the polarity of the welding generator. If the machine is equipped with a self-excited field, in addition to the separately excited field, it greatly minimizes the tendency to accidental reversal of polarity.

Repairing Garbage Reducers By Welding

By W. E. PALMER
Hollup Corporation

An interesting use of welding is found in the Rochester, N. Y. garbage-reduction plant, which is located but approximately one-half mile from the city. Whereas, generally, such plants are located at a far greater distance from the locality served, in this instance disagreeable features are eliminated by the use, under supervision of J. Kurzrock, plant superintendent, of special design and arc welding.

The plant consists of forty reducers, the functions of which are to heat and treat garbage. During the thirteen years of its operation, twenty reducers have been rebuilt with the use of welding. The corrosive action of acetic acid generated in the plant operation made such rebuilding periodically necessary. One-half-inch boiler plate is reduced to one-eighth inch in eleven years average time, and it is necessary to rebuild at critical points to counteract the acid's ravages.

Due to the rising fumes, the greater part of the corrosion occurs at the top of the reducers, and it becomes necessary to weld on a new head to replace the old riveted head. Fig. 1 shows the old unit, of bolted and riveted construction. The head was cut off just below the rivet line. The round loading door shown in this picture was in a pitted and corroded condition, permitting loss of naphtha fumes. This door was repaired with the use of Hollup No. 20 Electric Bronze, for complete protection against acid action. Deposits made with the arc showed sound, non-porous welds, entirely machinable.

Fig. 2 shows a reducer with the head cut away. The rings at the bottom of the tank are rebuilt grooves, which were created by the grinding action of metal hidden in the refuse on the bottom. All staybolts were welded in and reinforced with Hollup No. 30-S electrodes. The inside edges of the tank at the bottom were also welded in. The special points of wear, caused by metal scrap getting under the agitators, are particularly noticeable at the inside bottom edges.

In Fig. 3, operator is welding on the head. Part of the completed weld can be seen on the front right edge. Castings and head are welded both inside and outside. When this photograph was taken, the castings were partly welded to the top side of the head.

The final assembly is shown in Fig. 4. The beam was welded with Hollup No. 30-S electrode to the completely welded head without recourse to rivets or bolts. The loading door was left removable so that interchange between use of one head or another would be possible, as the arc-welded bronze door ring will outlast the heads. The inner ring of the loading door had been machined to a smooth surface, built up layer upon layer, with No. 20 rod, to the following dimensions: 30 in. diameter; face of ring, 2 in., and depth, 1½ in. The finished rings present non-porous and smooth surfaces, insuring the retention of naphtha vapors. Insulating material is placed on the reducer, and the loading door cover placed in position. The steam jacket is subject to 85 to 100 lb. pressure. The pressure inside the reducer tank is lower than atmospheric, and the back pressure is 2 lb.

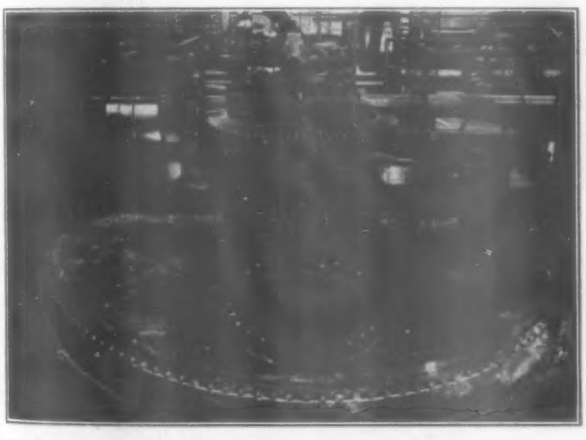


Fig. 1. Old Unit of Bolted and Riveted Construction.

Fig. 2. Head Cut Away and Grooves in Bottom Built Up.

Fig. 3. Welded Head and Castings in Place.

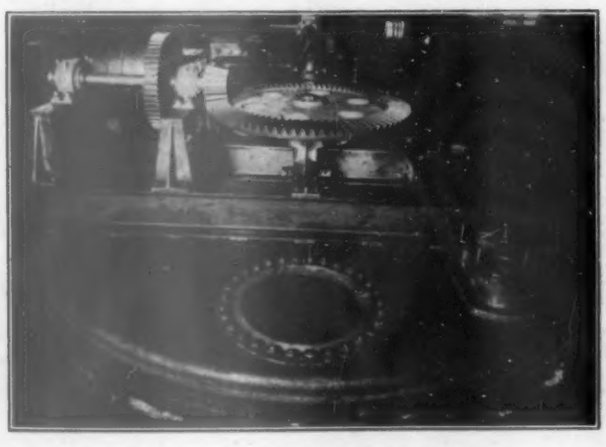
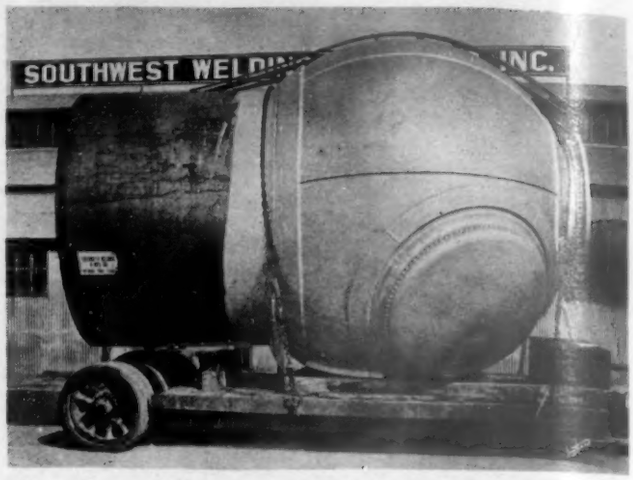


Fig. 4. The Completed Welded Job.

Design and Construction of a . . . . .

Welded Spherical Manifold



■ By W. E. ARCHER
Staff Correspondent, The Welding Engineer

WELDING has been employed extensively on one of California's major construction jobs, which has been under way for the past several years. This project, which is now almost completed, is the building of the Hetch Hetchy Aqueduct by the city of San Francisco to bring in water from the mountains to supply the people of San Francisco and environs. The completed project will have cost more than $100,000,000, it is estimated, and will serve a huge population.

Over 200 Miles of Tunnels and Pipelines

It is interesting to note that the water passing through the Hetch Hetchy Aqueduct will travel a distance of over 200 miles, by way of tunnels, open conduits, welded steel pipe and concrete pipe lines, to its terminating point in San Francisco. This large aqueduct will serve all the cities on the peninsula of the San Francisco Bay region.

In this huge project, many welding problems of importance were encountered in the construction of the steel pipe conduits, the solutions to which were found only after extensive investigations and analyses.

The last section of the aqueduct is made up of what is known as the Irvington Tunnel, which has a bore of 10 ft. 6 in. and is over 13 miles long, the western outlet being located approximately two miles south of the city of Niles. This city is situated on the east side of the bay and is some 40 miles south of the city of Oakland. This tunnel outlet is known as the Irvington Portal. The tunnel is lined with concrete.

For purposes of distribution of the water, it was necessary to install a steel sphere manifold on the west outlet of the tunnel. This large sphere, which is shown in the accompanying illustration, is approximately 14 ft. in diameter and 22 ft. long, and has three diversion outlets.

Welded Design Takes Preference Over Riveted

The original requirements in the specifications covering this job called for riveted construction; however, the Southwest Welding & Manufacturing Co., of Alhambra, Calif., who were awarded the contract for the fabrication of the sphere manifold, are boosters and strong advocates of welded construction. Their Engineering Department, after analyzing the riveted design and finding objectionable features to this type of construction. recommended to the construction engineers of the Hetch Hetchy project, that the sphere could be satisfactorily fabricated by welding it. A welded design was submitted and approved, with the result that the large manifold was fabricated by welding.

For the most part ¾-in. steel plate was used in the construction of the manifold. Steel requirements called for flange-quality Serial No. A-89-30, A.S.T.M. steel. Stress relieving of the plates, after they were formed to the correct radii, was specified. Eight sections were required to make this sphere, each being formed by fold pressing to give the manifold its correct spherical shape.

Procedure for Welding Sections Together

Assembly was carried out by tack-welding the eight sections together to form the entire sphere before any of the actual welding was started. The tack welds were spaced at about 12 in. After this temporary tack-weld assembly of the sphere, the actual welding was started. In the welding, the matter of warpage from contraction and expansion due to the welding heat was controlled by a special welding procedure, in which the welders would work at opposite points from each other on the sphere and shift their positions frequently to other seams. This avoided the overheating of any large area at one time and held the locked-up stresses to a low figure. Only shielded arc welding was permitted.

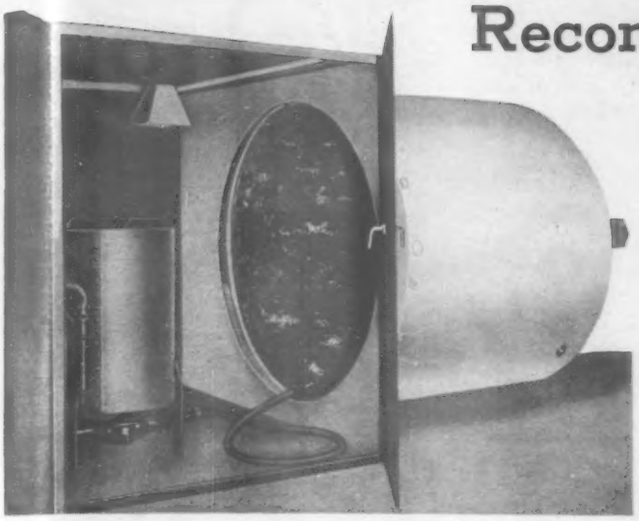
The sphere manifold has three outlets, one 72 in. in diameter, and two 60 in. in diameter. These outlets consist of hot-forged welding necks welded to the sphere, and are closed by dished and flanged heads riveted to the necks. These connections, however, are only temporary ones.

Heavy plates, 1¼ in thick, were welded around all openings to support the reduction of materials, and were closely fitted before actual welding was started. The complete sphere manifold was fabricated in the presence of inspectors of the State of California, who were in charge of all material and welding tests during the process of fabrication. Hand welding was employed exclusively. In preparing the edges of the plates for welding, they were planed on both sides to an angle of 30°. Thus welds of approximately equal thickness were made on both the inside and outside. As many as 12 passes, or beads, were required in finishing some of the welds on the large seams.

Meets Requirements for Class 2 Pressure Vessels

In the final acceptance of the sphere manifold by the engineers of the water project, many comments were made regarding the class of fabrication and welding performed on this unusual undertaking. Welding was performed in accordance with the requirements for A.S.M.E. Class 2 unfired pressure vessels. Welded coupons were given tensile tests, and were examined by x-ray, using the fabricating company's own recently installed x-ray equipment. All x-ray photographs showed good-quality and highly uniform welds.

The completed manifold was shipped from the Alhambra plant of the Southwest Welding & Manufacturing Co., by water to Oakland; thence it was trucked to the location, and there installed by the Southwest Welding company's field crew.



Reconditioning Ice-Cream Mixing Tanks by Welding and Metal Spraying

■ By R. J. McWATERS
All-Weld Company Limited

Jacket in Position for Sand-Blasting Inner Surface.

WELDING and its allied process, metal spraying, work hand-in-hand to develop business for the Toronto firm of All-Weld Company Ltd.

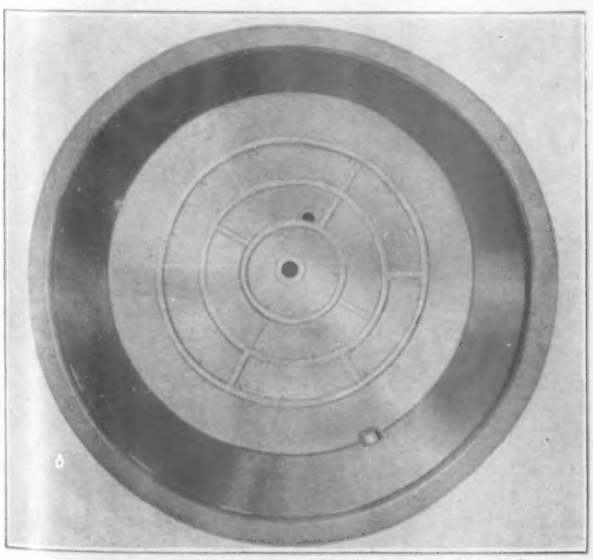
THE established process of welding and the comparatively new one of metal spraying are already working hand in hand with very evident success. Contrary to a somewhat prevalent idea, welding will not be replaced by metal spraying, but ever since our welding shop has been equipped with metal-spraying equipment, each process has been bringing in work for the other.

Our plant has been doing job welding for many years and, with others, suffered from lack of business. We added a complete "Metallizing" equipment and accessories to our facilities and, as a result, have kept the plant busy during ordinarily slack months, because soon after completing our installation we obtained a contract entailing a very considerable amount of both lines of work.

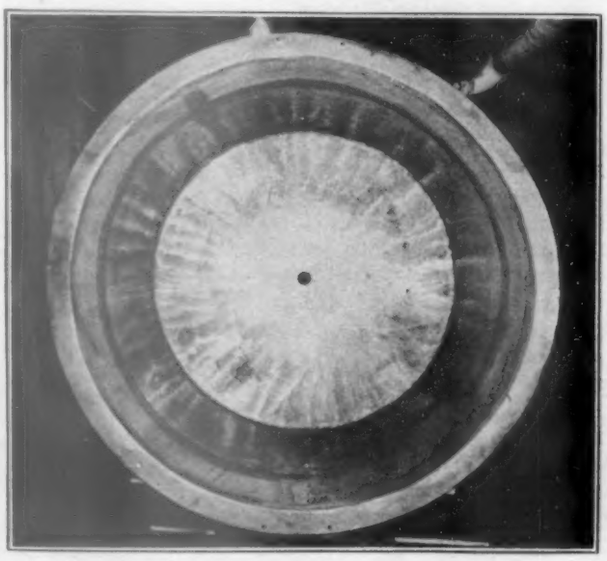
Glass-lined steel tanks with steel jackets welded thereto were installed a few years previously in an ice-cream manufacturer's plant. The tanks were used for mixing ice cream, and a brine solution was sprayed into the jacket to cool the mixture. This caused a very rapid corrosion of the steel, until finally the inner shells collapsed because of the loss of metal. These shells were removed from the jackets, which were found to be badly pitted on the inside although not beyond use if the heavy corrosion could be stopped.

We were consulted and asked to quote on replacing the units. We made a tender, which was accepted, on supplying seven new stainless-steel tanks of 1000 Imperial gallons capacity, the old jackets to be reclaimed by metal spraying, and then welded to the outside of the stainless steel.

The stainless-steel vessels were made 6 ft. in diameter by 6 ft. deep. No. 10 gage "Staybrite" sheets, polished on one side, were obtained in 36-in. widths, necessitating a number of seams throughout the shell and dished bottom. The sheets were formed and tacked and then welded lightly from the inside. This weld drew the seam in so that the welds were slightly raised. This permitted us to grind these welds easily without damaging the polished surface. These seams were then ground on the exterior to remove any scale, and were then heavily welded. This exterior welding drew the seam back to flush in most places; but where not, a heavy wooden mallet was



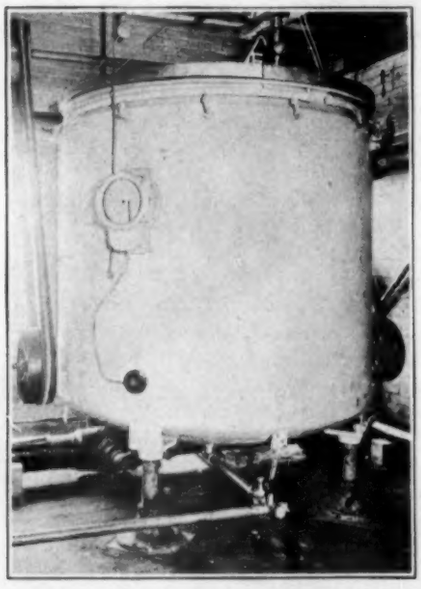
Interior of Jacket Sprayed With Lead.



Stainless-Steel Tank Fabricated by Welding

used to flatten the seam. These outer welds were cleaned with a hot caustic solution and then the inside was polished where ground, using 20, 80 and 120 grit discs on a rotary air polisher.

Steel plates were welded into the badly eaten portions of the jackets, and stuffing boxes were welded in to fit the outlets in the stainless-steel tank. The steel was then sand-blasted to remove the heavy scale, and then sand-blasted again with steel grit to provide the roughened surface necessary for a metal-spraying base. Lead was applied with a "Hi-Speed Metallizer." One and one-half pounds of metal was sprayed to the square foot, leaving an impervious coating of 0.020 in. This coating will



Completed Tank of Stainless Steel With Lead-Lined Jacket.

effectively withstand the brine solution and will not be affected by any ammonia that might leak into the brine.

During the coating work it was necessary for the operator to wear a compressed-air mask to guard against lead poisoning. The work was done in a room with an exhaust system for quickly removing the heavy fumes and dust.

The stainless-steel tanks were then lowered into the lead-coated jackets and welded in place around the outer edge of the flanged top. Stainless-steel outlets were screwed into the inner shell through the stuffing boxes, and our work was completed.

This contract for seven units required over 7000 lb. of stainless-steel sheets, about 350 lb. of heavily coated stainless-steel electrodes, 2000 lb. of steel plate, and 2100 lb. of lead wire. Approximately 1600 cu. ft. of acetylene and a like amount of oxygen were used in the metal spraying operation.

When the equipment was put in service, it was found that the cooling time was cut in half because of the greater thermal conductivity through only ⅛ in. of clean stainless steel between the ice-cream mixture and the cooling solution, compared with the heavily scaled ¼-in. steel plate with the glass coating that was formerly used.

The corrosion on the outer sheils has been ended by the lead coating, and our customer now has an installation that will last indefinitely. All this was obtained for only about half the cost of the original equipment.

This is only one of many instances where we have saved customers money through the use of our combined facilities. We are replacing wooden vats lined with sheet lead by new welded steel tanks metal sprayed with lead; corroded brine and water storage tanks with zinc-coated vessels, and worn shafting with high-carbon wearing surfaces.

Our venture into metal spraying has been most successful, not only because of the business that we are doing in this line, but because the process has been a material aid in increasing our welding work. At present, we are operating three "Metallizers" for applying metal-sprayed coatings.

Welded Boiler Drums for New Cruisers

The Navy Department has awarded contracts for the boiler and superheater drums and appurtenances for the cruisers *Brooklyn* and *Philadelphia* to the Combustion Engineering Co., Inc. The contract includes 64 welded drums and contains an option for similar equipment for one, two or three additional vessels. These vessels are being constructed at the Brooklyn and the Philadelphia Navy Yards, respectively, and the boilers will be built at the yards.

Stainless-Clad Piping With Arc-Welded Seams

A larger order for stainless-clad steel is being fabricated by arc welding into an 1800-ft. pipe at Milwaukee, Wis.

This unusual pipe, 2 to 5 ft. in diameter, and ¼ in. thick, will carry compressed air from rotary turbo-blowers to aeration tanks at the Milwaukee Sewage Disposal Plant on Jones Island. It is being built by the Cream City Boiler Co., Milwaukee, Wis., fabricators of alloy metal equipment, who will also do the field welding. This is the first time that stainless-clad steel has been used for this type of work.

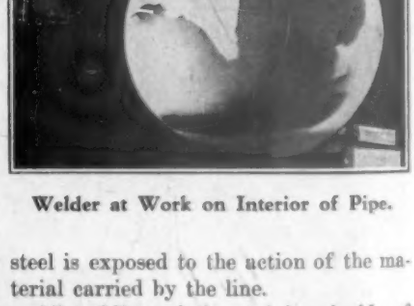
The pipe is a main air header which will convey air under pressure for activating raw sewage. Welded stainless-clad steel construction was decided upon because of the low internal coefficient of friction which it provides and which will be maintained practically for life. Due to this low internal friction, the pipe was designed several inches smaller than would have been the case with cast-iron pipe for the same purpose. With this decrease in diameter, it is possible to install the pipe in existing structures. Cast-iron pipe would have required expensive changes to the buildings. Arc welding was decided upon as the most economical and the fastest means of fabrication.

Most sections of the pipe are 54 ft. long. These are made up of nine plates, ¼ in. thick. Each single plate is formed and placed in a special welding clamp for making the longitudinal seam. This is a plain butt weld, made with 18-8 stainless-steel electrodes on the inside and with heavily coated mild-steel electrodes on the outside. The welding speed is about 50 ft. per hour.

Nine of these plate shells are then welded together to form one section. The circumferential joints are butt welds. The plates have previously been sheared square and are placed with a 3/16-in. gap between the edges.

About 1325 feet of the pipe is 5 ft. in diameter. The rest is 48, 36, 30 and 24 in. The contract required the fabrication of several special elbows, tees and fittings.

Expansion joints are made of 10-gage solid stainless steel. All flanged connections are so made that only stainless



Welder at Work on Interior of Pipe.

steel is exposed to the action of the material carried by the line.

All welding of the stainless inside of the pipe is being done with ⅛ to ¼ in. "Stainweld A" electrodes, and the steel side of the pipe is being welded with 1/4 and 5/16 in. "Fleetweld" electrodes. All electrodes, as well as the 400-ampere welder, are products of the Lincoln Electric Co., Cleveland, Ohio.

Approximately 315,000 lb. of ¼-in. stainless-clad steel and 9000 lb. of 10-gage solid stainless steel are required for the project.

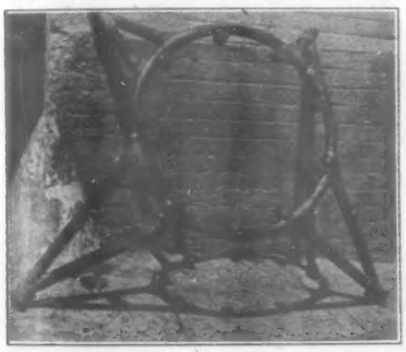
The job, which will cost approximately $107,000, is scheduled for completion by the first of December.

Arc-Welded Frames of Chrome-Molybdenum Steel

A contract for a group of airplane-motor teststand adapters has just been completed by the Combined Machine Corp., San Diego, Calif., using arc-welded chrome-molybdenum steel.

After aeroplane motors are rebuilt it is customary to mount them on a test-stand and run them in for several hours before mounting in a plane. To secure an approximation of the actual air circulation operating conditions, and to eliminate the necessity of changes in oil lines, control levers, etc., the adapter illustrated was designed.

Due to the great strain and vibration encountered, it was necessary to use materials that have the greatest resistance to fatigue; for this reason chrome-molybdenum steel was specified throughout. On the adapter shown, the central ring and the legs are seamless tubing of ⅛-in. wall thickness, while the pads on the inside of the ring are 1½-in. solid stock. Precautions had to be taken against weakening the tubing upon the application of heat, but it was found that the electric arc had no detrimental effect.

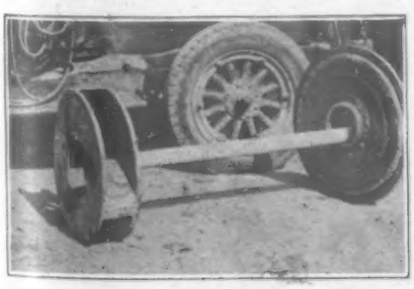


Adapter Built of Tubing and Pads.

The tubing was bent cold before welding. Welding was done with "Fleetweld" electrodes, manufactured by The Lincoln Electric Co., Cleveland, Ohio. A contract for another lot of these adapters has since been awarded to the same company.

Manganese-Steel Suckers Repaired by Welding

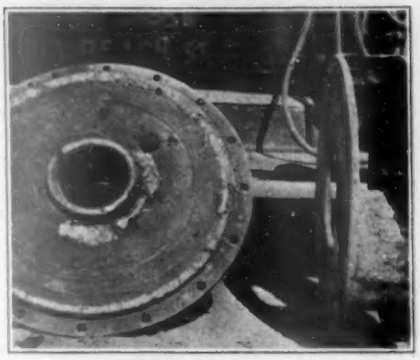
Worn suckers from gravel pits, costing approximately $300 new, are being repaired at an average of $80 each, by the Reliable Welding Works, 1813 Beach St., Flint, Mich. This concern works closely with the gravel pits, and, as a result, has built up a good business in this kind of repair.



Welding Saves $220 on Each Sucker.

Each sucker consists of a 6-in. shell, a fan, and two side plates. The average life of new suckers, which are of cast manganese steel, is from three to six months, at which time the castings are badly eroded by the gravel and are worn through completely in places.

The procedure used by the Reliable Welding Works in repairing these suckers consists of building up the spots where the casting is worn completely through with a nickel-steel arc-welding rod. After all holes have been completely filled, a cushion stock consisting of a layer of "Stoody Self-Hardening" rod is applied wtih the electric arc to those surfaces which are to be hard-faced. The final layer of hard-facing material is "Stellite," which is also applied with the arc, about 10 lb. being required for each casting.



Holes Are Filled and Wearing Parts Are Hard-Faced.

Get "*H. O. T.*" on Welding

■ By H. O. T. RIDLON

[This section is dedicated to Better Welding and Better Welding Shops. Suggestions and criticisms are invited.]

The thought for the month: Do every welding job so well, that even he who does not know this art of ours, will thoroughly appreciate that *you* know your business.

• • •

Noticed this in a welding paper recently: "Editorial—Pipe Welders Needed." It was a swell editorial, but heck that's not news. We've all been aware of that for years. Good *welders* are always needed.

• • •

Society Note: Pittsburgh papers please copy. That splendid gentleman and purveyor of welding equipment from western Pennsylvania, James Curtis (Jimmy) Dawes, visited the Windy City for the Century of Progress, with his family during the early part of August.

• • •

Well, I'll be gosh durn, *Industry & Welding,* that dandy little free publication on welding, crashes into the mystic and dramatic with a new line by the "Trouble Shooter." It's really a nice line with some fine hints in it. But hell! why all the secrecy? Who's the man of mystery?

• • •

My good old friend, Joe Goehring, big boss of the Liberty Brazing & Welding Co., of Pittsburgh, is one of the real old timers in the game. Joe has promised me a story of the "good old days," when welding was brazing, and done with brass spelter. He's got some of the old torch catalogs that say cast iron can't be welded. He also has some of the real old torches, which provide a record of those days and of the men who paved the way for the growth of the welding industry.

• • •

Now regarding this here World's Fair, as we call it here in Chicago, but which is officially known as A Century of Progress, it's really a swell show, and in the opinion of your most humble scribe is way and above the show they put on last year, which we all thought was swell. Don't pass it up if you can help it, even if you were here last year; and if you were not, Mister, I'm telling you to stretch a point and be sure to get here, for I feel certain that you will never regret it. And don't forget my latch string is always out when you come to "Chi."

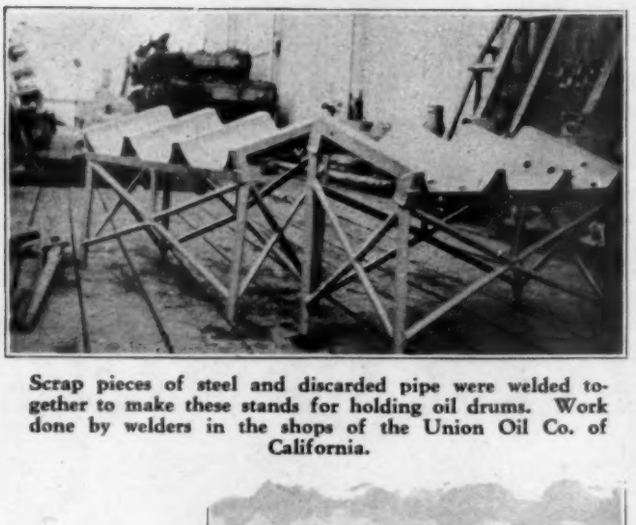
• • •

And speaking of shows, today I got a peek at the proposed program of the meetings that are to be held during the National Metal Congress, which holds forth in New York City during the first week of October. Now if you guys want to see and learn things about this here new industry of ours, you sure can get a heap of it mighty fast by attending that session. That's one thing you never want to pass up if you can help it. Great stuff these welding conferences, believe you me.

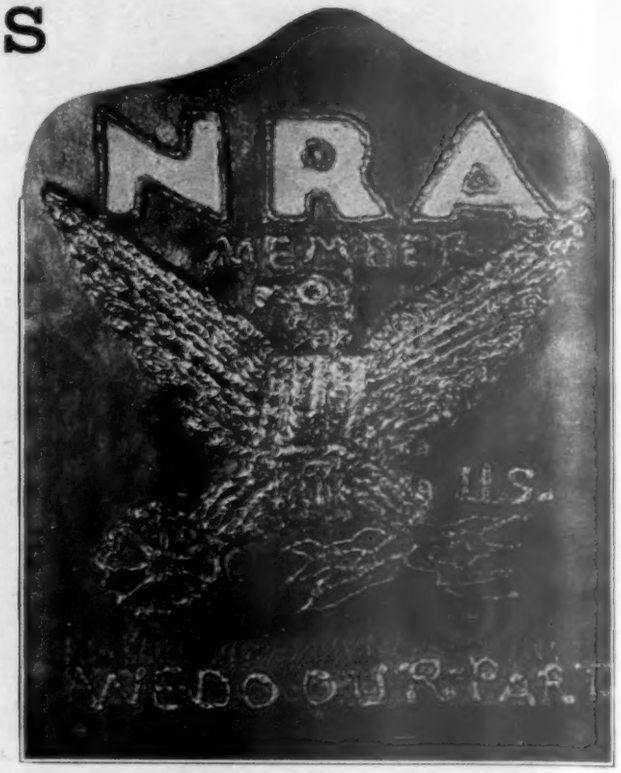
• • •

P. S. Hold to your dreams, Son, some day they may come true and in the meantime they will give you much comfort.

WELDING NEWS IN PICTURES



Scrap pieces of steel and discarded pipe were welded together to make these stands for holding oil drums. Work done by welders in the shops of the Union Oil Co. of California.

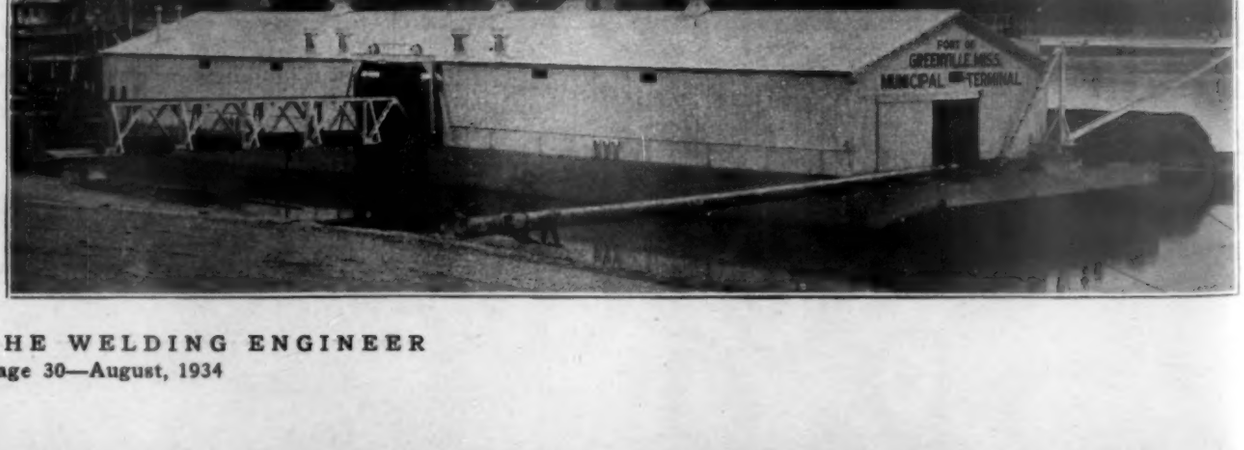


R. V. Trevillyan, of San Bernardino, Calif., made this "Blue Eagle" plaque by means of the metallic arc. The eagle's eye is of glass and is welded in place.

This 4-in. welded gas pipeline remained intact, though the flood waters carried away the supporting bridge. (Photograph courtesy Air Reduction Sales Co.)

This welding unit, for both electric and gas welding, owned by Nourse Watson, is a common sight in the oil fields around Seminole, Okla.

Wharf boat, 230 ft. long, built entirely by arc welding, rises and falls with the level of the Mississippi River. (Photograph courtesy The Lincoln Electric Co.)



Structural-Steel Welding in Southern California

A number of interesting projects involving welding structural steel have recently been completed or are under way in Southern California, as follows:

The Pacific Iron & Steel Co., of Los Angeles, Calif., recently finished a large welding contract for the Riverside Cement Co. The job consisted of reinforcing by welding of a 300x900-ft. steel building, originally a riveted structure erected several years ago. Errors in design, wrong selection of material, and the lack of proper bracing in the building's construction, made it necessary to use 300 tons of steel in the reinforcing on this job. The work was completed in 8 hours. Welding provided the only way of eliminating the necessity of wrecking and rebuilding the structure, which procedure would also have been a much more costly one. John Bertone, superintendent for the steel company supervised the work.

The Shockey Boiler Works, 125 W. Market St., San Diego, Calif., recently completed extensive plant changes, including a new all-welded office building of steel and sheet metal. The office site has been moved, changing the entrance to the working yard, thus effecting added convenience in handling large jobs. The concern specializes in all-welded fuel-oil storage tanks for fishing boats.

The Flemming Forge & Iron Works, of Long Beach, Calif., recently completed the construction of an all-welded plant at 1275 West 11th St. The frame of the new building is of welded pipe and steel, and is designed to withstand any strain occasioned by the city's well-known hazard—earthquakes. D. B. Flemming, owner, recently moved his equipment into his new building from his old location at 1570 Anaheim Blvd.

Warner Brothers, motion picture producers, of Hollywood, Calif., are doing a great deal of welding at this time in the erection of ferris wheels, merry-go-rounds, and other carnival equipment, preparatory to the making of scenes for a new picture now in course of production.

The framework of the new Catholic Church at Third St. and Cerritos Ave., in Long Beach, Calif., just recently completed, is of all arc-welded steel construction. One hundred tons of steel was used in this edifice. The Pacific Iron & Steel Co., of Los Angeles, were awarded the contract for this work.

The Commercial Welding Works, of 2750 Norton Ave., Lynwood, Calif., has just completed the construction of a brewery, both building and equipment of which is of as nearly all-welded construction throughout as was possible and practical. The plant, which was built for the Lynwood Brewing Co., is just north of the Commercial Welding Works, whose welding equipment was used.

WARNING!

Two men traveling together in a Studebaker car with Ohio license No. 48498, have been defrauding welding shops and industrial firms of money for subscriptions to *The Welding Engineer*. One signs the name of R. E. Ovens, and is about 40 years old, almost 6 ft. tall, blond, blue eyes, and slender. These men are not representatives or agents of The Welding Engineer Publishing Co. and have no authority to act for or solicit subscriptions for the publications of the company. Anyone locating them will please immediately notify *The Welding Engineer*, 608 S. Dearborn St., Chicago, Ill., by telegram or long distance 'phone, collect.

Iron and Steel Engineers to Hold Session on Welding

A technical session devoted to welding constitutes a part of the tentative program of the annual convention of the Association of Iron & Steel Electrical Engineers, to be held in Cleveland, Ohio, Sept. 18th to 20th. All sessions will take place in the Statler Hotel, while the Iron and Steel Exposition will be held concurrently in the Cleveland Public Auditorium.

The Welding Engineering Division holds its session on Sept. 20th, the program including the following subjects: High spots in welding; nitrogen in arc welds; gas welding and cutting relative to the iron and steel industry; aluminum welding; tube control in connection with resistance welding; the application of meters to welding; and thermit welding.

Further information regarding the convention and the exposition may be obtained from J. F. Kelly, managing director, Association of Iron & Steel Electrical Engineers, Pittsburgh, Pa.

Portable Sawmills of Welded Construction

Portable sawmills, in which welding is quite extensively used, are being manufactured by the Sinker Davis Co., of Indianapolis, Ind., for lumbermen who find their source of supply in small quantities, necessitating frequent change of location.

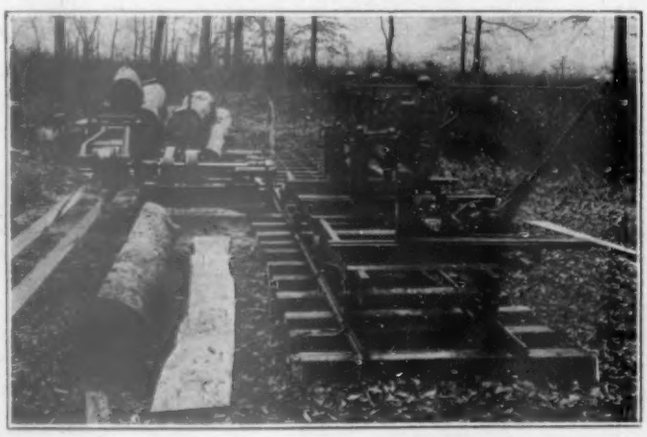
The sawmill is belt-driven from a tractor or a gasoline engine mounted on a base anchored to the ground. The unit illustrated is of the tractor-operated type.

The mill consists of two parts. One is called the "husk frame" and contains the sawing machinery. The other is the carriage, on which the timber rides up to the saw. The controlling lever, for controlling the thickness of the cut, is also a part of the carriage.

The "husk frame" is constructed of 8-in. channels, all welded, with reinforcing angles welded in the corners. To enable the frame to be quickly dismantled and assembled when moving or setting up, all parts are bolted to the frame.

The carriage operates on a lightweight track set up on railroad ties. The frame of the carriage is constructed of channels for sides and cross members. Tubular cross members are also used at intervals for stiffness. The frame is entirely arc welded. The axle boxes are steel castings and are permanently welded to the frame.

Each unit has three cast steel head blocks, which are used to shift the logs over the desired distance before feeding them into the saw. These head blocks are mounted on the carriage, and each operates on its own base, which is welded to the carriage as a unit. The head-block base unit is constructed entirely by welding and consists of two Z-bars with bridging.



The Husk Frame and Carriage of this Sawmill Are Shop Welded and Field Bolted.

Gear Guards Formed of 18-Gage Sheets.

Carbon-Arc Welding of Oil-Tight Gear Guards

The carbon arc is being used in the welding of light sheet metal in the plant of Brad. Snodgrass, Inc., in Indianapolis, Ind. An example of this process is the welding of oil-tight gear guards, shown in the illustration. These guards are made of 14-gage sheets and are welded with a $\frac{1}{4}$-in. diameter carbon, a speed of approximately 18 in. per minute being obtained. The plates forming the packing boxes around the shaft openings on each side of the guards, are fastened to the guards by spot welding.

Detroit Weldery Has Well-Equipped Plant

Equipped with modern facilities for cutting, welding, and handling material, the Walter J. Thomas Co. plant is one of the largest and most interesting welding institutions in the Detroit territory. The plant is now located in the old Ford Motor's Co.'s plant in Highland Park, into which it was moved a short time ago. Over 19,000 sq. ft. of floor space is utilized.

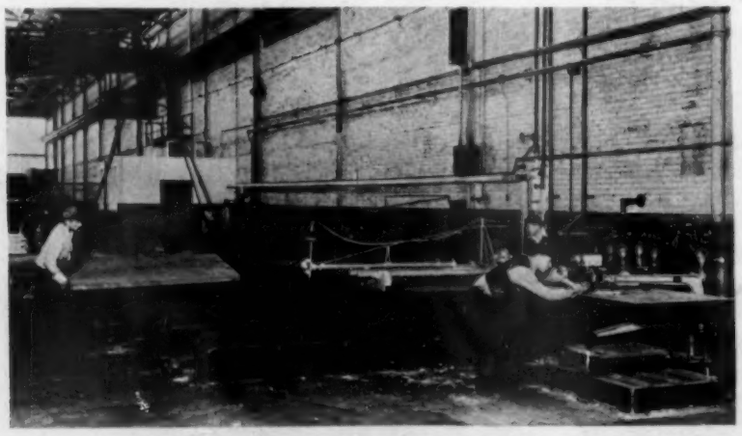
Equipment includes arc welders rated at 600, 300 and 200 amperes for shop use, portable gas-operated equipment for out-of-shop demands; equipment for bronze welding, oxyacetylene welding, atomic-hydrogen arc welding, thermit welding, and metal spraying; three mechanical cutting torches capable of cutting various gages of metal up to 20 in. thickness; also welding slabs for accurate work, 10-ton and 5-ton overhead traveling cranes, high-pressure gas system for preheating, and compressed-air service for chipping and sand-blasting.

Work includes reclamation of castings and other metallic parts, as well as fabrication and production by welding and cutting for some of Detroit's largest industrial concerns. Typical jobs include the fabrication of piping, stainless-steel covers for use with heat-treatment furnaces, steel gears built up from rolled shapes, steel press frames, die sets, and fixtures and jigs.

The plant has A. S. M. E. boiler construction approval, and contains facilities for testing and inspecting, including hydrostatic pumps testing up to 5000 lb. per sq. in. The plant also is licensed by the Department of Commerce Steamboat Inspection Service.

Walter J. Thomas, head of the company, a man of wide experience in the welding field, has built up an organization of craftsmen who enjoy the respect and confidence of the company's customers.

Weldery Is Located in the Former Ford Plant.



The Thomas Plant Is Well Equipped for Shape Cutting.

Orders for Welded Trains Increase Employment

Between four and five hundred additional men will be employed by the Edward G. Budd Manufacturing Co., of Philadelphia, to build the high-speed, welded stainless-steel, stream-lined trains that one Eastern and one Western railroad have recently ordered.

Following the building of the famous "Zephyr" for the Chicago Burlington & Quincy Railroad, which train was described in the July issue of *The Welding Engineer*, this railroad recently ordered two more trains, to be operated between Chicago and Minneapolis and St. Paul.

The Budd company has also begun construction of a stainless-steel, streamlined train for the Boston & Maine Railroad, to operate between Boston and Bangor, Maine, through Portland.

Edward G. Budd, president of the company, points out that these new trains, in addition to boosting the employment at the Budd plant, will also provide employment in the mills furnishing the stainless steel and in the plants providing the Diesel engines, as well as in other industries throughout the country.

Trains similar to the "Zephyr" will be in general operation within ten years, it is Mr. Budd's opinion.

New Equipment

Arc Saw Cuts Metal With Speed and Economy

A metal-cutting saw, employing an electric arc to bring the metal to be cut to a plastic or molten condition, has been put on the market by the Rich Manufacturing Co., Ltd., 3851 Santa Fe Ave., Los Angeles, Calif. The cutting current can be delivered by a d.c.

Arc Saw and Mounting Frame.

motor-generator set or by an a.c. welding transformer. The pressure created by the high speed of the saw blows the molten metal from the scarf as the cutting proceeds.

The saw is of circular form, of comparatively soft steel, and carries a multitude of small straight teeth on its circumference. It is rotated at a high speed.

The arc, which is formed between the teeth of the saw and the material to be cut, is concentrated directly in front of the teeth. As the rate of travel through the material is high, the arc is concentrated at any point for only an instant. Therefore, it is explained, the overheated area at the sides of the scarf is very narrow, being not over one millimeter in depth.

The width of the cut is only slightly greater than the width of the saw, being approximately $\frac{1}{32}$ in. in the case of a ¼-in. thick saw. The cut itself is said to be at least as smooth as that made by a cold saw.

Cuts have been made on spring steels, manganese steels, hard-facing alloys, tungsten and tantallum carbides without trouble or injury to the blade, it is said. Tempered steels can be cut without affecting their temper. As the arc does the work, hardness of the material has no effect.

Besides cutting, this saw can also be used as an arc-threading, arc-milling and arc-turning machine.

As examples of the high speed of cutting and low cost of operating these saws, the following are cited: A steel plate, 24 in. in width by 1 in. in thickness, was cut through in 29 seconds. The saw motor and the motor driving the generator consumed a total of 0.324 kw.-hr. at a cost of 0.3 cent. A 10-in. steel channel was cut in two in 16 seconds at a total cost of 0.2 cent for electric power.

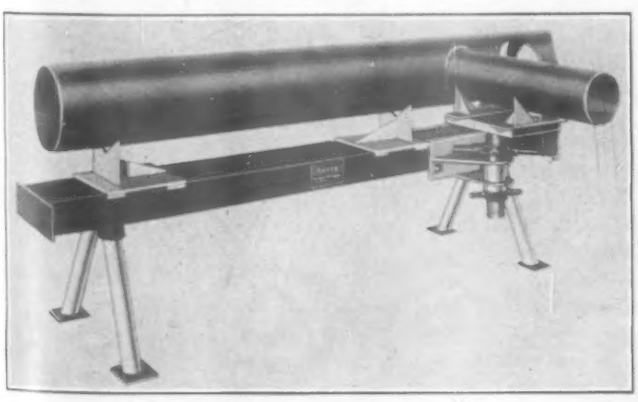
Assembly Bench for Pipe Welding

A new type of pipe welding assembly bench has been announced by Oster-Williams, 2057 East 61st Place, Cleveland, Ohio. This new fixture is said to be capable of handling any size of pipe up to 12 in. in diameter, for lining up accurately and holding in position for tacking fittings, flanges and branches at any angle. For handling long lengths, an extension bench can be supplied, which can be moved to any angle with the main bench.

An adjustable elevator, which can be used at any position on the main bench or on the extension, controls the vertical alignment of the work. Accurate angle alignment is obtained by setting the elevator to the desired angle. The elevator supports are graduated.

The general construction of the bench makes for solidity without excessive weight. The main bench and extension consist of an I-beam mounted on tubular legs, with sufficient spread to eliminate tipping. Elevating and V-supports are all steel. The bench is quickly disassembled and reassembled, making for portability.

The main bench weighs 700 lb. and the extension 300 lb. The main-bench I-beam is 8 ft. long and the extension 6 ft. long. Both are 1 ft. wide and 2 ft. high.

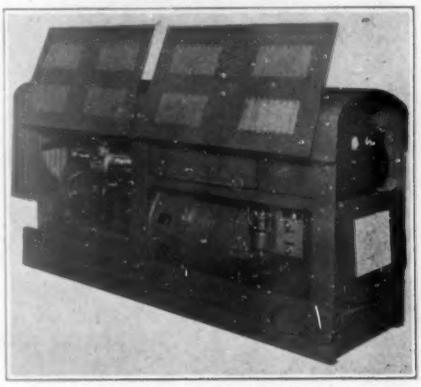


Piping Is Easily Assembled for Welding on Branches, Fittings and Flanges.

Close-Coupled Welder Has Gas-Engine Drive

A new close-coupled gas-engine-driven "Shield-Arc" welder of 300-ampere, 40-volt capacity is announced by The Lincoln Electric Co., Cleveland, Ohio. Due to the close-coupling feature, the new unit is much more compact and of lighter weight than previous models.

The generator is mounted on the engine housing with the drive lined up on



Compact, Light-Weight Welding Unit.

hardened steel and driven on cushioned rubber. This method of coupling takes care of any misalignment and reduces vibration.

Because there is less vibration, the engine operates at a high efficiency and gasoline consumption is lowered, according to the manufacturer. A special idling device, which cuts the engine speed when the arc is broken, further assures economical operation of the six-cylinder engine.

The welder is supplied mounted on a rigid steel base with totally enclosed steel side curtains. Where desired, the complete unit is mounted on small wheels for outside use or on a two or four wheel pneumatic-tired trailer.

A uniform generator current permits use of a higher average current with

greatly increased welding speed. The capacity of the new welding machine is 60% higher than its predecessor, and it is rated at 40 volts. According to the manufacturer, the "Shield Arc" welder has 10% higher efficiency at full loads than the former machine, and still more on overloads, even though it is of much greater capacity.

Other features of the "Shield Arc" welder include dual control of welding heat, sparkless commutation, handy-height controls, and arc-welded steel construction.

Lincontrol, a new remote current-control device which enables the operator to adjust the current by merely tapping the electrode on the work, is supplied as optional equipment and requires no additional cables or rheostat to be carried by the operator.

Wide-Vision Helmet for Face Protection

A helmet for protecting faces from disfigurement and eyes from injury from flying particles or injurious fluids has been developed by the American Optical Co., Southbridge, Mass., and is known as their No. 660 helmet. At the same time, this new helmet gives the wearer wide-angle horizontal and vertical vision, all with a high degree of comfort.

New Helmet Prevents Face Injuries.

It is made of tough fiber and is provided with large, clear lights of laminated safety glass. For welders working on galvanizing tanks or chipping out metal, it will give comfortable and dependable protection against fumes or flying particles.

Eliminating Light Flicker Due to Spot-Welder Loads

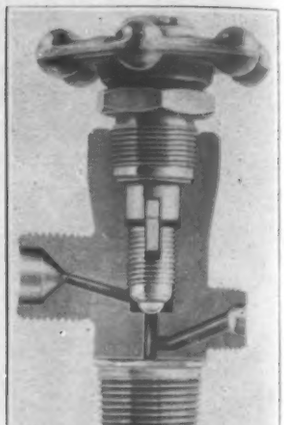
For eliminating visible light flicker that results from instantaneous heavy loads of spot welders or from the starting and stopping of motors, the "Kathetron Out-Voltage Regulator" has been developed by the Roller-Smith Co., 233 Broadway, New York, N. Y. This device is very simple and compact, and consists of a booster transformer, an impedance transformer, and a "Kathetron" tube control unit. The "Kathetron" is described as an electronic tube whose grid voltage varies in relation to the load, and thus it is made to control the output of the booster transformer.

Stainless-Steel Ball Valve for Oxygen Cylinders

More than 96% of all its oxygen cylinders are now being equipped with valves having a stainless-steel ball seat, reports the Air Reduction Sales Co., 60 East 42nd St., New York, N. Y.

While the valve proper closely resembles the older type of valve in appearance, and opens and closes easily, it is said also to possess superior sealing qualities and does not corrode or score and cause leaks.

For over three years similar types of hardened stainless-steel ball valves have been used on all Aireo-DB welding and cutting torches. Their use has demonstrated that torches so equipped rarely require valve repairs other than the occasional renewal of valve-stem packing.



Ball Seat Does Not Corrode or Score.

Trade Literature

"The Application of Monel Metal and Nickel to Industrial Processing Equipment" is the title of a booklet recently issued by The International Nickel Co., Inc., 67 Wall St., New York, N. Y. Besides giving data on the physical and mechanical properties of these materials, the booklet contains considerable miscellaneous information, including instructions on the selection of suitable welding rod and other details on fabrication. Application tables are included, arranged alphabetically according to the material to be handled.

The arc welding of steel fireboxes by the "Plastic-Arc" process is the subject of a folder issued by G. D. Peters & Son, Ltd., Windsor Works, Slough, Bucks, England. Each step of the process is described as it is applied to the welding of tubes into the tube sheet, applying patches, welding firebox plates, welding thermic syphons to roofs of boxes, and welding the crown, sides and bottom seams.

The use of welding in the forming of special or unusual shapes and parts is discussed, and explanatory diagrams shown, in Series 2, of Application Sheet No. 39, entitled "Elements of Design," published by The Lincoln Electric Co., Dept. 239, Cleveland, Ohio.

"101 Uses for the Air-Acetylene Flame" is the subject of an illustrated pamphlet discussing soldering, brazing and heating operations. Copies are available from The Linde Air Products Co., 30 East 42nd St., New York, N. Y.

"The Shielded Arc" is the title of a booklet issued by The Lincoln Electric Co., Cleveland, Ohio, discussing the advantages of shielded-arc welds as regards structure, physical properties and corrosion resistance, and briefly describing the manual metallic-arc process and the automatic carbon-arc process. Photomicrographs and weld specimens after testing, are shown.

General specifications of Lincoln "Shield Arc" welders, based on N.E.M.A. specifications of 300, 400 and 600 amperes, are tabulated in Welder Specification Bulletin No. 30, issued by The Lincoln Electric Co., Cleveland, Ohio. A description of these units is also included.

"The Maintenance of Reciprocating Parts" is the title of an illustrated pamphlet issued by The Linde Air Products Co., 30 East 42nd St., New York, N. Y., describing the application of bronze-welding to the rebuilding of pistons, bull rings, valves, and other parts.

A portable ventilator applicable for removing welding fumes from confined spaces, is described in Bulletin 168, issued by the Coppus Engineering Corp., Worcester, Mass. Advantages and features of construction are listed.

Commercial News

In the Colonial Village at A Century of Progress, Chicago, is a reproduction of the Boston house of Paul Revere, in which is an exhibit of Revere Copper and Brass Incorporated, the ancestry of which is traced back to Paul Revere's original copper mill at Canton, Mass., a wooden model of which is on display. Attendants in colonial costumes distribute copies of a booklet, "The Secret of Paul Revere," which is filled with interesting and little-known details regarding the famous patriot's commercial life, including the smithing of gold and silver, cartooning, dentistry, etc., and contains a hitherto unpublished poem of his. Check-book blotters in copper and brass are distributed as souvenirs.

The Taylor-Winfield Corp. has opened a plant at 14307 Third Ave., Detroit, Mich., having a complete engineering staff, experimental department, machine shop, transformer department, assembly department, and facilities for manufacturing special resistance welders, as well as a department for redesigning and rebuilding used equipment. The main plant of the company, at Warren, Ohio, will continue to manufacture standard machines as well as special resistance welding equipment.

The Chicago Steel & Wire Co., 10257 Torrence Ave., Chicago, Ill., on July 1st discontinued the retail sales organization of its subsidiary, the Fusion Welding Corp. The parent company, who manufactured the complete line of welding rods for the Fusion Welding Corp., will continue to be active in the welding field by marketing welding rods through jobbers and distributors throughout the United States, states L. F. Collins, vice-president.

The McLean Welded Products Corp., 530 West 79th St., Chicago, Ill., has been incorporated for $10,000 and has issued 200 shares of common stock with a par value of $50, according to G. A. McLean, president. The company will engage in the business of rebuilding worn equipment and hard-surfacing and will offer their services as welding engineers and contractors.

The line of welding electrodes and other products of the Karl Strobel Corp., Los Angeels, Calif., are now being manufactured in the plant of the Rich Manufacturing Co., Ltd., 3851 Santa Fe Ave., Los Angeles, Calif., whose research and consulting departments are in charge of Mr. Strobel, who will also supervise the manufacturing of these products.

W. H. Bassett, metallurgical engineer, American Brass Co., passed away on July 21st. Mr. Bassett, who was a pioneer metallurgist in the brass industry, was the recipient of many honors from professional societies, and assumed the presidency of the American Society for Testing Materials only three weeks prior to his death.

D. A. Nemser has been appointed development engineer with The International Nickel Co., Inc., with headquarters in Hartford, Conn., it is announced by Dr. J. F. Thompson, vice-president of the company. Mr. Nemser was formerly chief metallurgist with the Pratt & Whitney Manufacturing Co., of Hartford.

A course on metal radiography will be given by St. John X-Ray Service, Inc., Long Island City, N. Y., at their laboratories at 30-20 Thomson Ave., during the week of Oct. 8th, which is the week following the American Welding Society fall meeting in New York City.

W. H. Hobart, of Troy, Ohio, sailed July 7th on the *Ile de France* for a tour of several weeks in the British Isles and continental Europe. He is combining a pleasure trip with a business mission for the Hobart Brothers Co., of which concern he is executive vice-president.

The Westinghouse Electric and Manufacturing Company has appointed the Hart Welding Supply Company of Oklahoma City as their official welding dealer for the entire state of Oklahoma and the Panhandle of Texas.

Revere Copper and Brass Incorporated, Baltimore Division, Baltimore, Md., has announced the opening of an office at 911-912 Rhodes-Haverty Building, Atlanta, Ga., with Walter W. Fitts as district representative.

James J. Dale has been elected vice-president in charge of sales of The Allsteel Press Co., Chicago, Ill. Mr. Dale formerly held a similar position with the Henry & Wright Manufacturing Co., of Hartford, Conn.

The Universal Power Corp., Cleveland, Ohio, has appointed Metalweld Incorporated, 2617 Hunting Park Ave., Philadelphia, Pa., as distributors of "Universal" arc welders in the Philadelphia district.

Notes From the Field

Remodeled Shop Can Handle Both Big and Little Jobs

Facilities for handling work expeditiously are very important to promote and hold business, in the opinion of Sylvester Rodney, proprietor of the Rodney Welding & Boiler Works, 336 E. Prospect, Alliance, Ohio. Hence, he is making extensive alterations to his shop and property in order better to serve his customers and facilitate the work in the shop.

Recently he purchased the property on which his shop is located, including a 2-story building, and he is now removing the second-story floor and raising the roof, which will give him a shop ample in size and inside height to handle practically all classes of work.

The doors are being made larger in width and height to accommodate even the highest trucks, and new steel cross beams are being installed, as well as a new traveling crane.

New water and gas lines, entirely welded by the oxyacetylene process, are also being installed. Gas is to be available in every part of the shop for preheating purposes.

All the structural work, as well as the steel door frame, was arc welded by the shop's force.

The total cost is estimated at approximately $1500.

If It Can't Be Welded They Take It to Mr. Robb

By specializing in the welding of aluminum and white metal, since most welders seemed to steer clear of these, the A. J. Robb Welding & Machine Shop, Mantilona, Mich., is now getting most of this kind of work for 40 miles around.

Observing that most welders were either "taking a stab" at this kind of work or telling the customer that "it can't be welded," Mr. Robb decided to learn how to weld these metals. He read what he could find on the subject, and applied himself diligently to mas-

tering the technique, with the result that those in his part of the state now look upon him as a specialist in this work.

A. C. Larsen, proprietor of the Peder R. Larsen Machine & Welding Shop, at 208 N. Freeman St., Oceanside, Calif., recently built a portable electric welding unit for use in extending the welding service of the shop. The unit, which is the first electric unit ever used in the shop, is made up of a home-made 200-ampere generator driven by a Model A Ford motor. Mr. Larsen recently took over the management of the shop following the death of his father, who for a number of years owned and operated the shop.

The Hollingsworth Tool Works, of Indianapolis, Ind., are specializing in the application of metal spraying and sand-blasting. A. V. Hollingsworth, manager, says he has found a commercial market for sand-blasting alone, and reports an increasing number of contracts for coating brewery tanks by the metal-spray process. This concern recently moved from 244 N. Gray St. to larger quarters at 101 S. Delaware St.

Roy E. Hanson, welding engineer and tank builder, of 1924 S. Compton Ave., Los Angeles, Calif., is moving his office building to the front of his lot, thus providing needed additional working space in his erecting yard. Mr. Hanson builds all-welded A. S. M. E. Code tanks and does general welding. He was associated for a number of years with the Southwest Welding & Manufacturing Co., of Alhambra.

The Badger Welding Works, under the joint ownership and management of Don Angle and Art Waggoner, recently opened for general oil-field welding and digging-bit servicing in the Weedpatch oil field, near Bakersfield, Calif. Mr. Angle, one of the partners, is also manager of the Triangle Manufacturing Co., of Los Nietos, Calif., engaged in welding and hard-facing work in the Santa Fe Springs field.

The welding of safes has been developed as a specialty by George Fraser, proprietor of a welding shop at 228 S. W. First Ave., Portland, Ore., who has helped out many of his customers who have either lost the combination to their safe or had the door blown off. Mr. Fraser has also built up a reputation in the welding of parts on motion-picture machines.

The Koppl Welding Works, oil-field service shop of Santa Fe Springs, Calif., recently built a portable electric welding unit for use in the local oil field. The unit comprises a Wilson 300-ampere generator driven by a Model A Ford motor. A new Ford truck with enclosed body makes a very neat and practical means of transporting the unit to and from jobs.

The Custombuilt Trailer & Body Works, featuring automotive repairing and general welding of all kinds, recently opened for business at 1505 Santa Fe Ave., in Los Angeles, Calif. This location was formerly occupied by the Electric Weld Co. M. E. Foster is owner of the plant, while Clarence Edwards is in charge of the welding department.

The Commercial Welding Works, of Signal Hill, Calif., recently installed a 300-ampere portable electric welding unit for oil field service. The unit comprises a Westinghouse generator to be driven on field jobs by a '24 Studebaker motor, an electric motor being used for shop work when desired. D. E. Judkins is manager of the shop.

H. Joor, welding-shop owner of Escondido, Calif., is doing a large amount of welding and hard-facing work on equipment used in the construction of a 26-in. steel water line near that city, which is being laid for the Mutual Water Co. Mr. Joor recently added a new 300-ampere General Electric welding unit to his shop equipment.

The Reliable Welding Works, of 1522 East 9th St., Los Angeles, Calif., has moved across the street to No. 1603. The new location provides needed larger working space, and added facilities are being provided in the erection of a large crane for handling tanks, trailers and other heavy welding jobs. L. I. Tuttle is owner and manager.

A recent accident at the Hammond-Tillamook Lumber Co. in Rockaway, Ore., resulted in the death of Harry Painton, age 50, a welder. Mr. Painton was welding a locomotive cylinder head, when it blew off. Gas created within the cylinder by the heat of the torch is believed to have caused the explosion.

Francis Beaudette, until recently associated with a brother and operating the Beaudette Bros. Welding Works in Long Beach, Calif., is now connected with Heaston & Glimpse, of Huntington Beach, a general oil-field welding service concern. The brothers have closed their shop in Long Beach.

The George Welding Co., of Akron, Ohio, recently moved from 79 W. Exchange St. to larger quarters at 695 W. Bowery St. The company is headed by Dale S. George, president of the National Association of Welding Contractors, Inc., and specializes in building all-welded trailers.

Bamber & Co., well-known oil-field welding-shop owners, of Signal Hill, Calif., recently took over the shop and business of the Cummings Welding Works, in the Signal Hill district. No announcement has been made as to whether the newly acquired shop will continue to operate.

R. L. Shaffstall, of El Monte, Calif., formerly associated with the Prow-Leffler Welding & Machine Works, recently opened a job welding shop under his own name at 531 West Main St. Mr. Shaffstall will specialize in the repairing and hardfacing of rock-crusher equipment.

W. B. Mason, for 35 years connected with a number of large mills as a saw filer, has opened a saw-welding shop at 16 S. E. Hawthorne Blvd., Portland, Ore. Mr. Mason has made a reputation in the longitudinal welding of drag saws, using two wornout ones to make one saw.

Carl Neitzel recently opened the Franklin Machine Shop in Franklin, Ind., to do a general machine and welding business. Although Mr. Neitzel first learned the machinist's trade, he has also had approximately 16 years' experience at welding in steel mills and industrial plants.

The L. C. Hufford Machine Works, of Redondo Beach, Calif., is being extended by the addition of a welding department, which is in charge of E. G. Rowell. For his department, Mr. Rowell recently installed a new 200-ampere Westinghouse welding unit.

F. Dietrick, of Wilmar, Calif., recently took over the job welding and motor repair shop located at Del Mar Ave. and Valley Blvd. The shop was formerly operated by Fred DeGasser, who recently opened a welding shop at Noco, Calif.

The remodeling and altering of storage facilities for the Indiana Breweries, of Indianapolis, Ind., is being undertaken by the Emerson Scheuring Tank Co., of that city. Welding is being utilized for practically the entire job.

The Pacific Welding Works, of Los Angeles, Calif., recently opened for business at 1669 S. Alameda Blvd. The partners, M. Marco and H. L. Mills, formerly operated a shop at 1838 East 39th St. in Los Angeles.

The W & T Welding Works, of Huntington Beach, Calif., recently opened for

No good welder can afford to take a chance on the quality of his rods

MORE than a century of metallurgical experience accounts for the uniform composition and unvarying high quality of Anaconda Welding Rods.

Thousands of welders prefer them to all other brands. Good work requires uniformly dependable welding rods.

There are fourteen different Anaconda Welding Rods... a suitable one for every gas or electric bronze-welding purpose. Available through leading distributors. Usually shipped in bulk, but also obtainable in clearly labeled 10-lb. packages. Our new publication B-13, mailed on request.

MELTING POINTS OF ANACONDA WELDING RODS

Material	Approximate Melting Point—Degrees	
	Cent.	Fahr.
Tobin Bronze . . .	885	1625
Manganese Bronze	870	1598
Brazing Metal . .	930	1706
Naval Bronze . .	885	1625
Everdur	1019	1866
Phosphor Bronze A	1050	1922
Phosphor Bronze E	1070	1958
Phosphor Bronze D	1000	1830
Phosphor Bronze C	1025	1877
Silicon Copper . .	1083	1981
Deoxidized Copper	1083	1981
Electrolytic Copper	1083	1981
Nickel Silver . . .	1055	1931
Ambrac	1150	2102

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY

General Offices: Waterbury, Connecticut

Offices and Agencies in Principal Cities

In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ont.

NRA

ANACONDA WELDING RODS

business in their new quarters at 610 N. Main St. This concern specializes in oil-field welding, specialty tools, and hard-facing.

A contract for the building of a line of storage tanks for the Leiber Brewing Corp., Indianapolis, Ind., has been awarded the Emerson Scheuring Tank Co., of that city. These tanks will be of all-welded construction.

Stagner's Auto & Welding Service is the name of a new shop recently opened by Ernie Stagner, at 201 East Valley Blvd., in Alhambra, Calif. Mr. Stagner has been engaged in job-shop welding for over 14 years.

The welding shop of Reseck & Meyers, at 5003 Alhambra Ave., Los Angeles, Calif., was recently acquired by Mr. Reseck as sole owner, and will be operated in the future under the name of Ben T. Resick.

Vic's Welding Works, at 2906 S. Main St., Los Angeles, Calif., has been changed to the name of Consolidated Welding Service. The shop will continue under the management of V. C. Halberg.

Heaston & Glimpse, oil-field tool and welding specialists, with headquarters at Huntington Beach, Calif., recently opened a new branch at Weedpatch, a small oil-field town near Bakersfield.

Charley Adcock, proprietor of the Electric Weld Co., Los Angeles, Calif., has opened a shop at 825 Santa Fe Ave. Mr. Adcock features heavy welding work on trucks, trailers, etc.

A blacksmith shop located at 120 Granada Ave., in El Monte, Calif., has been taken over by H. R. Nevius, who has added both acetylene and electric welding equipment.

The American Iron Works has been established in Portland, Ore., by John E. Benson, formerly with the Harrison Foundry & Machine Co. and the Bethlehem Steel Co.

W. B. Owen has taken over the job welding department of the Steam Specialty & Machine Co., at 311 South 1st St., Louisville, Ky.

The Associated Welders, of Fremont, Ohio, are engaging in the manufacture and sale of welded trailers.

· CLASSIFIED ADS ·

Help Wanted—75c per line, minimum 4 lines. Jobs Wanted—4 lines free. Other Ads—$1.00 per line, minimum 4 lines. Count 8 words to line. Add 6 words for keyed address.

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Will Barney Noonan please advise us his present whereabouts? Is he aware that it is a criminal offense to remove a mortgaged machine without the consent of the owner? $25.00 will be paid for locating this machine #P20-251-2512-H9-6282-169049. Electric Arc Cutting & Welding Co., Newark, N. J.

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